Washington State Department of Ecology
Spill Prevention, Preparedness and Response Program

WAC 173-182
Oil Spill Contingency Plan Rule

Preliminary Cost Benefit Analysis (CBA)

TABLE OF CONTENTS

Executive Summary

The proposed draft oil spill contingency planning rules revise and consolidate two existing chapters of rules into a new chapter of rules (Chapter 173-182 Washington Administration Code (WAC)). The two existing chapters of rules are Chapters 173-181 WAC (facility plans) and 317-10 (vessel plans) that were adopted in 1991 and 1993 respectively, pursuant to state law (Chapters 88.46 and 90.56 of the Revised Code of Washington).

The following factors were taken into consideration when drafting the proposed rules:

- The technical expertise and administrative experience the Department of Ecology (Ecology) has gained during 15 years of implementing existing contingency plan rules. These include – “lessons learned” from responding to spills of various sizes, participation and evaluation of hundreds of oil spill drills, technical studies, literature reviews, extensive feedback from plan holders and other stakeholders, administration of the contingency plan and contractor review and approval process, and other factors.
- During the original rule adoption process, that took place in the early 1990’s, representatives from industry recommended that the rules be adopted without incorporating specific spill response planning and performance standards. As a result of this input, the state adopted and applied these requirements in a guidance document. Ecology has determined that its existing guidance should be formally incorporated into its rules and has achieved this incorporation in the new proposed rules.
- Findings from this preliminary Cost Benefit Analysis (CBA) regarding both quantitative and qualitative costs and benefits of the draft rules.

The proposed draft rules and this preliminary CBA are available for public review and comment until July 26, 2006. Ecology welcomes comments on all aspects of this preliminary CBA. For more information on the rules, economic analysis, opportunities to provide public comment, and other related information, the reader may wish to consult the Ecology web site at www.ecy.wa.gov/spills/spills.html or contact Linda Pilkey-Jarvis at (306) 407-7447.

Overview of Costs and Benefits Analysis

The analysis of costs and benefits of the proposed chapter of rules is one factor Ecology used to decide how to best implement its statutory mandate to write rules. In preparing this preliminary CBA, Ecology evaluated both the qualitative and quantitative cost and benefits that would accrue through implementation of the rules, as well as the specific directives of the statutes that the rules implement.

This analysis finds that the probable *quantitative* costs of the proposed rules appear to outweigh the probable *quantitative* benefits, not including all of the potentially probable quantitative benefits of improving response to a "worst case oil spill" in the state of Washington. However, Ecology believes that the sum of the probable quantitative and qualitative benefits; and the benefits of implementing the specific directives of the statutes, justify the rules as currently drafted.

Therefore, based upon the probable quantitative and qualitative benefits described within this report, and the specific directives of the statutes, Ecology has determined that the total probable benefits of the proposed draft rules that accrue to society as a whole outweigh the probable costs of implementation.

Small Business Economic Impact Statement

The proposed chapter of rules as amended has disproportionate impacts on small businesses. A Small Business Economic Impact Statement has been prepared. Ecology has incorporated the following provisions into the draft rules to reduce the compliance burden on small businesses: longer phase-in period to come into compliance, process to request alternative compliance, encouragement for umbrella planning (single plan submission covering multiple vessels or facilities) and mechanisms to share costs of drills.

Least Burden Analysis

The proposed draft rules incorporate cost reducing features while providing the minimum requirements that are likely to improve response to a "worst case spill" as required by law. Some cost reducing features include, use of a single plan to meet both the federal and state requirements, and allowing plan holders to reference the Northwest Area Contingency Plan.

1.0 Introduction

1.1 Background

The Legislature directed Ecology to establish a comprehensive regulatory program that protects our natural, cultural, and economic resources from the damages of oil spills. A new regulatory chapter of rules (Chapter 173-182 WAC) is proposed that revises and consolidates two existing chapters of rules: Chapters 317-10 (vessel plans) and 173-181 WAC (facility plans). The existing chapters of rules have been in place since the early 1990s. This is the first time they have been amended.
State law (RCW 34.05.328), requires that prior to adopting a proposed rule, all agencies in Washington State must:

> *"…(c) determine that probable benefits of the rule are greater than its probable costs taking into account both qualitative and quantitative benefits and costs and the specific directives of the statute being implemented."*

The preliminary CBA is required by RCW 34.05.328 and .320(1) (l) contains:

- Background information on oil spill risk and spill response;
- An economic analysis of the probable costs and benefits of the proposed Contingency Planning rules (Chapter 173-182 WAC);
- A Small Business Economic Impact Statement (see RCW 19.85 and RCW 34.05.320(1)(j)); and
- A Least Burdensome Alternative Analysis (see RCW 34.050.328(1) (e)).

1.2 Oil Spill Risk Management

Over 20 billion gallons of oil and hazardous chemicals are transported through Washington State each year, by ship, barge, pipeline, rail, and trucks. Washington's waters support some of the most productive and valuable ecosystems in the world, and spills on land or water can threaten public health, safety, the environment and the economy. Equipment failure, human error and natural disasters can lead to unintended and potentially enormous consequences. Even small oil leaks, drips and spills can result in cumulative impacts that degrade an ecosystem by a "thousand cuts."

The mission of the Spills program is to protect Washington's environment and public health and safety through a comprehensive spill prevention, preparedness and response program. The Spills preparedness section focuses on protecting Washington waters by maintaining a continual state of readiness in case of large and small oil spills. Operators of larger commercial vessels and oil handling facilities are required to use state approved oil spill contingency plans. These plans help to assure that when oil spills occur, the responsible party is able to rapidly mount an immediate, effective response.

1.3 Oil Spill History

The impact of oil spills on an ecosystem varies by the type and degree of oiling, timing and location of spill, length of exposure and the timing and effectiveness of the response. The same can be said for the cost of cleaning up a spill, although the lack of pre-spill data makes any post-spill cost analysis complex. At the height of the response to the Exxon Valdez spill, more than 11,000 personnel, 1,400 vessels, and 85 aircraft were involved in the cleanup. Trajectory computer models and historical experience informs us of what such a spill in Puget Sound, off the Washington coast or on the Columbia River might entail. The majority of areas within Puget Sound are not subject to large scale flushing, and oil tends to remain in the environment and quickly begin to impact shorelines. Spills on the river system tend to flush down stream and either move out of the river or strand on shorelines near back eddies of the river. Tidal and river flow influences can cause re-floating and re-oiling above the high tide area. In addition, oil that strands on the shoreline is often driven into the sediment and continues to be toxic for some time. It is not an underestimate to believe that the same level of resources needed for the spill in Alaska would be needed here as well. Some of the largest spills in Washington's history have occurred off the Washington coast and have impacted both Canada and Oregon. Spills on the coast prove to be a great logistical challenge due to shoreline access and the volatile ocean conditions.

The need to respond as soon as possible, with systems of equipment that are enhanced for maximum effectiveness, is critical to increase the opportunity for on-water recovery and reduce shoreline oiling. The proposed chapter of rules emphasizes early response actions. In addition, the proposed rules speak to tracking the oil in low light or darkness conditions, and aerial support to help guide skimming systems into the oil. The rules require a systems approach, as have the federal rules, in an attempt to provide all of the pieces necessary for efficiency (skimmers, boom, workboats and storage). The proposed rules require practice drills and inspections of the equipment. This ensures that the equipment will work and that operators know how to put these complex recovery systems together. These drills also allow all of the participants in a spill to practice working together in advance of an emergency. All of these things provide for a qualitative benefit to be gained by the citizens of the state. We are better prepared, with the correct equipment, with partnerships forged ahead of time and can more rapidly and effectively clean up oil, minimize impacts and protect the unique environment of Washington State.

Examples of worst case volumes for planning in Washington:

- Facilities range in volume from 50 barrels for a smaller fuel transfer site to more than 655,000 barrels for a Puget Sound refinery.
- Typical tank and non-tank vessels range from 5000 barrels to more than 900,000 barrels.

1.4 Specific Directives of the Statute that the Rules Implement

State law directs Ecology to adopt contingency planning rules that must meet a high standard. This standard is well above that required by federal vessel and facility response planning rules. Specifically RCW 88.46.060 states:

"… (1) Each covered vessel shall have a contingency plan for the containment and cleanup of oil spills from the covered vessel into the waters of the state and for the protection of fisheries and wildlife, shellfish beds, natural resources, and public and private property from such spills. The department shall by rule adopt and periodically revise standards for the preparation of contingency plans…(b) Be designed to be capable in terms of personnel, materials, and equipment, of promptly and properly, to the maximum extent practicable, as defined by the department, removing oil and minimizing any damage to the environment resulting from a worst case spill..."

Similarly, RCW 90.56.210 states:

"…(1) Each onshore and offshore facility shall have a contingency plan for the containment and cleanup of oil spills from the facility into the waters of the state and for the protection of fisheries and wildlife, shellfish beds, natural resources, and public and private property from such spills. The department shall by rule adopt and periodically revise standards for the preparation of contingency plans…(b) Be designed to be capable in terms of personnel, materials, and equipment, of promptly and properly, to the maximum extent practicable, as defined by the department removing oil and minimizing any damage to the environment resulting from a worst case spill…"

In addition, the 2004 Washington State Legislature (see RCW 90.56005 (2)) adopted a "zero spill goal" finding that:

"…the primary objective of the state is to achieve a zero spills strategy to prevent any oil or hazardous substances from entering waters of the state."

The draft rules help achieve this goal by improving plan holder awareness of the costs of spills, leading to investment in spill prevention and response, and by increasing the rapidity with which oil is removed from the environment immediately after significant spills.

However, small to moderate sized oil spills are a continuing reality, and while they are infrequent, major oil spills have and will continue to occur in Washington waters. Therefore the legislature determined that the level of regulation for oil spill contingency plans requires removing oil and minimizing damage from a worst case spill. Through this statement, the legislature determined that the benefit of preserving Washington waters and shorelines outweighs costs of complying with contingency plan requirements for spills up to a worst case release.

2.0 Comparing Cost and Benefits

The proposed rules have been reviewed and the probable quantitative benefits may not outweigh the probable costs. Because it is difficult to attach dollar figures to all benefits and values, the legislature has mandated that agencies consider both qualitative and quantitative benefits and costs when performing cost benefit analyses, as well as the specific directives of the statute being implemented. RCW 34.05.328(1) (d).

However, there are important probable benefits to these rules that are qualitative rather than quantitative. The attached cost benefit analysis largely focuses on the probable quantitative benefits and costs of the contingency plan rules. While the rules' probable costs and expenditures are easily tabulated, converting subjective values into monetary equivalent is difficult and, in some cases, not possible. Probable qualitative benefits for which we have not assigned a monetary value include: effectively responding to a worst case spill scenario, preventing the ongoing detrimental impacts of a worst case spill scenario, protecting cultural and spiritual values of traditional tribal lands, decreasing impacts to endangered species, such as Puget Sound orcas, preserving recreational opportunities, creating a level playing field, and not rolling back contingency plan standards to where they were over twelve years ago. Probable qualitative benefits are discussed in greater detail below.

2.1 Qualitative Benefits

This section of the report is intended to inform the public of how Ecology considered and weighed probable qualitative benefits along with the probable quantitative benefits reflected in the analyses. This report does not identify probable qualitative costs associated with the rules as we were able to quantify all probable costs associated with these rules.

2.1.1 Current compliance by regulated community

Although the CBA reflects that these rules will result in "new" costs, it is important to remember that most industries have actually already incurred the majority of the costs over the last decade. There is a probable qualitative benefit to be gained from moving from the long standing guidance into rules. Standards developed in guidance give no assurance of stakeholder involvement in the process of development. Guidance could also be easily and frequently changed, thus there is a probable qualitative benefit gained by moving guidance to rules as industry and other stakeholders have more certainty and involvement.

There is also a qualitative benefit to not "rolling back" the standards to where they were prior to 1991, which would essentially return Washington to pre-Exxon Valdez standards.

Washington's waters, aquatic resources, and shorelines have been substantially protected since the existing rules and guidance were put into place in 1991. The goal of effective environmental regulation should be to allow for greater, not lesser, protection of the environment as technologies improve and costs of compliance can be phased in. Since most industries in Washington are already in compliance with the standards reflected in the proposed rules, weakening the existing standards would not be warranted as it would provide no incentive to new business to meet the standards of existing business and could allow even existing business to become lax in their contingency plan strategies.

2.1.2 Value of creating a "level playing field" for industry

Equity has a qualitative benefit. The rules help ensure that the contingency plan standards are enforceable by Ecology. Theoretically these proposed rules would not be necessary if all companies voluntarily complied with guidance. However, if voluntary compliance is not uniform, companies that do not do as much have a competitive advantage. If the existing rules are not revised to bring guidance into the rules, some companies may not be able to compete in the long term. They could either reduce their efforts or leave the market. If there are fewer companies to support the equipment needed to respond to worst case spills, then in the long term, cleanup and response effectiveness will be reduced.

2.1.3 Cultural and spiritual/ceremonial values

Human interest is not concerned with material or financial interest alone, but with beauty and a flourishing natural world as well. Valuing nature means engaging with rich and diverse cultural processes - the meanings, values, knowledge and practices which shape nature. The question is how our moral values for the environment can properly be articulated and taken into account in policy decisions. A fundamental problem with cost-benefit analysis that focuses heavily on quantitative benefits is that it overlooks the distinction between preferences and values. It treats all our commitments as simple market preferences, differing only in terms of strength. For example, the valuation of what you are willing to pay for some goods over another.

The environmental values shared by many Washingtonians are of deep historical and cultural significance and to Washington's tribes as well. Tribal culture is closely tied to and co-evolved with productive and functional ecosystems. Many of Washington's tribes are located near marine transportation corridors and have exposure to risk of oil spills. The Makah Tribe, for example, has a Usual and Accustomed marine area located at the crossroads of the Strait of Juan de Fuca and the Pacific Ocean. Their cultural resources are placed at the entrance to a United States high volume port complex, Canada's largest port, and the world's third largest Naval complex, a National Marine Sanctuary, a National Park, a National Fish Hatchery and a National Wildlife Refuge. If a spill were to occur in this area it may be possible to put a monetary value on the loss of resources. However, it may not be possible to place a monetary value on the loss of the connection of the tribe to its culture, environment and heritage.

In another real world example, the Doe-kag-wats estuary is known to the Suquamish tribe as the Place of Deer. The marsh and beach had a special value to the tribe and the spiritual and cultural impact that the Suquamish tribe felt when the marsh was oiled by the Foss Maritime spill at Point Wells in December 2003, cannot be fully quantified, though we can monetize the impact from the shellfish closures and restoration costs to clean the marsh.

2.1.4 Value of protecting endangered species

In 1999, the New Carissa spill off Coos Bay Oregon had a significant impact on the snowy plover population and the habitat for that species. That spill was not a worst case and yet the damage that was done is still being felt today. Although some cost-benefit methodologies allow us to attach a dollar figure to a particular individual bird, it is not as easy to attach a dollar value to the preservation of an entire endangered species, such as Puget Sound orcas, or preservation of endangered species habitat. A worst case spill has the potential to impact or eliminate endangered species that live in Washington in the water or on land.

2.1.5 Existence values

The marine shoreline of the state is about two thousand seven hundred miles long, a length greater than the combined coastlines of Oregon and California. There are roughly three million acres of submerged land and more than three hundred islands in our marine waters. The coast of Washington is a jewel of the Nation, with its vivid tide pools and undeveloped, rugged landscape. During certain seasons, we are host to migratory bird populations of international significance. Puget Sound was one of the first estuaries to join the National Estuary Program of the Environmental Protection Agency The Columbia River is the largest river in volume flowing into the Pacific Ocean from the Western Hemisphere, and is the fourth largest by volume in North America. With the importance of the Columbia to the Pacific Northwest, it has made its way into the culture of the nation. From the Woody Guthrie song "Roll on, Columbia":

> *"Roll on, Columbia, roll on, roll on, Columbia, roll on*
> *Your power is turning our darkness to dawn*
> *Roll on, Columbia, roll on."*

Like the Grand Canyon, people come from all over the country and world to see this great river and the surrounding habitat, environmental beauty and economic wonder. We must consider that the qualitative benefits extend beyond the borders of the state line.

2.1.6 Benefits of Preparedness

The cost of spills and the cleanup and damages, from an economic perspective, must be borne by the buyer of the final product. This is generally done through requiring the entity that created damage to restore the harmed party's interests. To do otherwise skews the competitive pricing structure that forms the basis for most economic analysis. Those who can escape liability have a competitive advantage. In the case of oil spills, complete restoration is not possible. The liabilities may be too large and under capitalized companies cannot pay it. Requiring preparation precludes undercapitalized ventures from shifting the costs of the spills to the public.

There is a direct correlation between the decision-making process during a spill and the final economic costs. Some qualitative benefits of preparedness include pre-spill risk analysis and mitigation, integration of good science and policy into spill decisions, a clear command/control organization for spill response, and ultimately collaborative, objective driven responses.

We have seen during the last 15 years that companies with a high regard for preparedness do better in drills and spill responses and have higher employee morale. There is a qualitative benefit to be gained through a culture of preparedness, increased worker productivity and morale.

2.1.7 Preventing On-going Impacts of a Worst Case Spill

Although much is known about the immediate harms to wildlife and aquatic resources arising from a major oil spill, we are just starting to learn how long these detrimental impacts continue following a spill. Scientists are still studying the impacts of the Exxon-Valdez spill 17 years after it happened and have found that the ongoing impacts from such a large spill are extremely troubling. These impacts include: patches of oil, whose most toxic components, have not dissipated since the spill in 1989. The lingering oil is still interfering with the recovery of animals in the intertidal areas of Prince William Sound, like clams, mussels and harlequin ducks.

The lack of pre-spill data as baseline makes it difficult to analyze. There is a substantial benefit to avoiding an Exxon-Valdez type spill here in Washington so that we never need learn firsthand how long the detrimental impacts will persist following the spill. Prompt and proper response is an important way to avoid the impacts that continue to be identified almost two decades after a major oil spill took place.

The infrequency of major oil spills may have contributed to the complacency that exacerbated the effect of the Exxon Valdez spill. This spill significantly influenced the development of both federal and state laws for prevention, planning and response. And today, in the wake of the aftermath of Hurricanes Katrina and Rita, there is again a national consensus that we must be better prepared to respond to natural and human caused disasters. In a report on the lessons learned from the Katrina response, the President found that despite reforms that encourage a proactive, anticipatory approach to the management of incidents, the culture of our response community has a fundamental bias towards reaction rather than initiative. As a result, our national efforts too often emphasize response and clean-up efforts at the expense of potentially more cost-effective anticipatory actions that might prevent or mitigate damage. Preparedness drives investment in prevention and another qualitative benefit of the rules could be derived from preventing a catastrophic oil spill as it will require affected industries to always be vigilant.

Summary of Qualitative Benefits

There are many qualitative benefits to be gained from updating the existing rules and moving the long-standing guidance into rules. Guidance is not fully enforceable and standards in rules provide more certainty to industry and other stakeholders. The value of creating a “level playing field” for industry is important, as all will be held accountable in the same manner.

The citizens of Washington have deeply held environmental values that are of deep historical and cultural significance to Washington’s tribes as well. Some qualitative benefits of preparedness include pre-spill risk analysis and mitigation, integration of good science and policy, a clear command/control organization, and collaborative, objective driven responses. Better preparedness in general will lead to a prompt and proper response which is an important way to avoid many long term impacts of spills as the oil is removed or contained earlier.

3.0 Principal Benefits of Using CBA

The cost benefit analysis is a useful tool to provide more efficient allocation of society's resources by better identifying which potential regulatory actions are worth undertaking and in what fashion. The method also produces more objective and transparent government decision-making by making explicit the assumptions and methods underlying regulatory actions. To a great extent, the legislature has already determined the level of regulation that is required in Washington State for contingency planning (i.e., removing oil and minimizing damage from a worst case spill). However, the cost benefit analysis is useful in helping to further define the parameters of regulation within the bounds of the statutory mandate.

3. 1 Contingent Valuation: An Accepted Technique for Estimating Certain Qualitative Values

For many environmental regulations, it is not possible to attach a dollar value to the worth of an ecosystem, and protection of that ecosystem to the citizenry. Traditional cost-benefit analyses, which focus on quantitative benefits, may downplay or ignore the fact that citizens are concerned about risks to their environment and quality of living, to their families and others as well as to themselves. Market values may differ substantially from the personal values that Washingtonians attach to their surrounding environment.

For example, one technique to monetize benefits is the "contingent valuation". During the Exxon Valdez oil spill, people were asked how much they individually would be "willing to pay" to protect the shoreline from future oil spills. This willingness to pay was presented as estimates of the "value" of pristine wilderness. However, contingent valuation methodologies often confuse what one is willing or able to pay with the value that the persons place on the health of their environment.

Contingent evaluation is based on individual's private decisions as consumers or workers, not on their public values as citizens. However, policies that protect the environment are often public goods and are not available for purchase in individual portions. In another example, a group of students, in their role as citizens, might be opposed to commercial ski development in a nearby wilderness area, but, in their role as consumers, might plan to go skiing if the development was built.

The public willingness to pay for prevention of oil spills has been consistently high in the literature. Unfortunately there is no similar study on willingness to pay for other aspects of cleanup. Given the values expressed for prevention and given public concern with cleanup, it is likely that people would indicate sufficient willingness to pay.

3.2 Using the Monte Carlo Simulation to Calculate Cost Benefit Analysis

When we use the word simulation, we refer to an analytical method meant to imitate a real-life system, (for example the impact of an oil spill), especially when other analyses are too mathematically complex or too difficult to reproduce.

Without the aid of simulation, a spreadsheet model will only reveal a single outcome, generally the most likely or average scenario. One type of combined spreadsheet and modeling is the Monte Carlo simulation (see Appendix 9 for formula). This method randomly generates values for uncertain variables, over and over to simulate a model. An example of such modeling may depict the distribution of oil during a spill and where it may impact the environment.

Monte Carlo simulation was named for Monte Carlo, Monaco, where the primary attractions are casinos containing games of chance. Games of chance, such as roulette wheels, dice, and slot machines, exhibit random behavior. The random behavior is similar to how Monte Carlo simulation selects variable values at random to simulate a model. When you roll a die, you know that a 1, 2, 3, 4, 5, or 6 will come up, but you don't know which for any particular roll. It's the same with the variables that have a known range of values but an uncertain value for any particular time or event (e.g. interest rates, staffing needs, stock prices, inventory, and phone calls per minute).

4.0 Summary of Costs

Before a spill occurs companies have typically spent tens of millions of dollars preparing for an effective response. This analysis deals with these preparedness costs. The probable cost and benefit of the proposed rules is partially a function of the sizes and types of spills expected, and the impacts they might have. Ecology has used existing data on typical spills in conjunction with the worst case spills modeling to extrapolate the probable costs and benefits.

Types of Expected Costs

It is expected that industry's costs will come from equipment that must be maintained in readiness for spills that could happen at anytime, the cost of writing and maintaining plans and conducting drills to test the plans, the cost of personnel training, and the overhead of maintaining manpower. These are the costs typical of all emergency response preparations.

The vessels, facilities, and response contractors reported annualized costs totaling $36 million for the existing system of plans, training, personnel, equipment and contracts. The proposed rules will change little of this. Approximately $7 million of this cost is due to the guidance that is now incorporated into the proposed rules amendments.

Types of Expected Benefits

It is expected that industry's probable benefits will come in the form of increased on-water recovery, reduced shoreline impact and cleanup, reduced environmental damages and Natural Resource Damages Assessments (NRDA). Other probable benefits also include reduced passive use losses, remainder cost, and stockholder losses.

4.1 The Baseline and Assumptions

Each of the following is a potential baseline to use in the analysis of this report:

1. Washington law: The law requires full details in planning for a worst case spill. The existing rules are not specific as to the amount of effort and equipment that a worst case spill response entails, but requires that it be sufficient to respond promptly and properly to a worst case spill. This might have been interpreted to be a large amount of effort and equipment. However, that economic impact was limited by more detailed descriptions contained in the guidance written to accompany the rules. That guidance is not a rule and therefore is not used here to provide the baseline, but it nonetheless significantly limits the true costs imposed on vessels, facilities, and responders by the proposed rules.

2. Federal requirements: There are federal requirements which have different/longer timeframes allowed for response as a planning basis. The federal rules result in more centralized staging of equipment and personnel and slower deployment to outlying areas of Puget Sound and the Columbia River, but much of the training, drilling, and equipment requirements are costs under the federal baseline.

3. Existing response asset levels exceeding current regulation and guidance: Competitors do not like to share. In some high cost areas, particularly response equipment, the business community is collectively already doing more than the existing guidance and rules and more than the proposed rules require. In this case it is the business environment, not the rules that drives the capital investment, creating both costs and benefits. In other words the market as well as regulation has driven substantial effort and capital acquisition. The acquisition of capital in excess of the requirements may also be driven by: concern over spill liabilities, concern lest another company's spill equipment be tied up elsewhere, unwillingness to provide cost savings to a direct competitor through providing a contract, a wish to provide for one's own compliance without having to share capital with other companies, a wish to force other competitors into capital acquisition, or good opportunities combined with long term expectations of future needs for the equipment due to regulatory trends.

In making this preliminary CBA, Ecology has evaluated the shift from the federal requirements to the proposed rules because:

- the existing rules were more general and performance based;
- the guidance is not a rule;
- the federal requirements form an absolute minimum but are more specific than the rules;
- the proposed state rules adopt substantial portions of the guidance and has more specific requirements similar to the federal requirements.

In many ways the application of the guidance has been a long pilot testing of the proposed rules. For that reason, detailed costs for certain areas of existing compliance are available. The new costs above the existing program are limited to possible shifts in equipment and potential staffing of areas further away from the central Puget Sound, such as parts of the Columbia River, Neah Bay and the San Juan Islands.

5.0 Technical Analysis of Compliance Costs

The technical analysis outlined below breaks down the cost of existing state regulations and federal requirements of contingency planning which includes planning, response equipment, training, drills and overhead.

Contingency Planning

Preparedness involves a cycle of activity (e.g., developing plans, procedures and policies, training, purchasing and maintaining equipment, conducting drills and incorporating lessons learned back into plans). The cycle is necessary for an activity that requires coordination among a combination of federal, state, local, tribal, private sector, and non-governmental entities.

Existing rules as a baseline

The existing chapters of rules require that plans provide *full details*. Plans are approved for five years and may be reviewed again after spills and drills to look for lessons learned. Under the existing rules, plan holders were required to identify initial response actions, response teams, methods to contain and remove oil from water and shorelines, describe equipment locations, interim and permanent storage of wastes, identify a drill program and rely on response contractors that are approved by Ecology. The most explicit standards found in the rules are the one hour (for facilities) and two hour (for vessels) requirements to provide initial deployment of response equipment and personnel at the site of the spill, given suitable safety conditions.

Guidance*: The guidance to support the rules described benchmarks to further clarify the prompt and proper response standard. Equipment needs for various timeframes were dependent on the type of facility, type of oil and the geographic area (zone) in which the vessels transited. The equipment needs included boom, recovery and storage devices, over flights, in-situ burn and dispersants.*

Federal rules as a baseline

Many of the federal planning requirements are similar to the state's. [1] Federal standards for equipment are highest at facility transfer locations, and highest in locations designated as high volume ports. The Puget Sound has such a designation, while the Columbia River does not. Equipment times in general for the federal planning standards are longer and are calculated from a defined location (the local Coast Guard office for example), which tends to centralize equipment caching.

[1] BC-States Task Force Integrated Vessel Response Plan Format Guidelines for Tank Vessels.

In August 2005, the Coast Guard began to require that non-tank vessels (cargo, passenger, fishing, etc) submit contingency plans. The regulatory standards are contained in federal laws, rules and a Navigation and Vessel Inspection Circular (guidance). Final rules are under development. The state rules have required non-tank planning from the early 1990's. One result of the new federal rules should be that the costs to industry to maintain the equipment should be shared now across a broader community. Additionally, the state rules allow non-tank vessel companies to form cooperatives and share the cost of compliance collectively.

In addition, there are pending federal requirements for aerial observations and required capability for in-situ and dispersant use. It is estimated that the federal rules will become effective soon after the proposed state rules, and that the requirements will be aligned.

Anticipated change to planning by proposed rules

The new rules provide some streamlining of plan requirements, for example Ecology no longer requires a system for categorizing spills by size and type or writing scenarios for small and worst case spills. The rules capitalize on the regional planning efforts by allowing references to the Northwest Area Contingency Plan (NWACP) for environmental sensitivities (GRPs), disposal plan, ICS job descriptions, ICS process, communications systems, and description of the relationships with other plans. This results in a reduction in cost for plan upkeep. The development of umbrella plans is encouraged; for example, a company with several facilities or multiple vessels can submit one plan and gain a savings in plan upkeep. In the new rules, yearly updates or a letter to Ecology affirming no changes is required.

Current ongoing costs to develop plans and expected change

Businesses report costs for developing the contingency plans at over $750,000 per year under the existing rules. Over $400,000 of these costs are imposed by the federal requirements, with less than $300,000 attributed to the existing state rules. There are no costs attributable to this part of the proposed rules that are not already imbedded in the equipment cost estimate.

Anticipated change to equipment by proposed rules

As proposed, these standards either equal or exceed the federal contingency planning standards and address spill assessment, boom requirements, recovery and storage of oily waste, in-situ burn and dispersants, shoreline cleanup, aerial observation, and availability of workboats to support spill response. These proposed standards emphasize early response actions. Storage requirements have remained the same as described in the guidance, except for transfer locations and pipelines. In these areas it is expected that the storage can be met by relying on shoreside tank facilities. The proposed requirements will result in a wider distribution of response equipment, for example, staged closer to the coastal entrances to state waters and the San Juan Islands. It is believed that the new requirements can be met by restaging existing equipment, though some labor costs may be new.

The proposed rules no longer include a performance standard, but instead describe a systematic approach to confirming appropriateness and adequacy of equipment through drills.

The proposed rules also address planning for ground water. Early action standards for pipelines and pipeline tank farms are identified (under the guidance, these were determined on a case by case basis.)

Current ongoing costs for equipment and expected change

Equipment generates over half of the cost of the existing requirements. As discussed previously the impact of the proposed rules are defined based on the shift from the existing rules (federal and state) to the proposed rules. The shift in equipment is laid out in Appendix 1. That appendix provides a much better display of the changes than this discussion.

Looking at the detail in Appendix 1 the reader will find that for the Neah Bay staging area, the San Juan Islands, and some areas on the Columbia River, the proposed rules will impose capital costs if planholders do not cooperate. In the extreme, with no cooperation, the costs could be large. In the remainder of the state the existing equipment caches exceed the combined requirements of all existing rules and guidance, as well as the requirements of the draft proposed rules.

Storage capacity is the most likely issue to create large costs if capacity is not shared, and efforts to identify shoreside capacity are not undertaken. Ecology is open to comment from plan holders and spill responders on the likelihood of cooperation and/or additional costs.

The rules define how the timing of deployment of existing equipment will be calculated for planning purposes. The state rules will be compatible with the federal rules. The conservative assumption of 5 knots/35 miles per hour travel speed used by Ecology may be slower than the actual delivery speed. Ecology will use 5 knots/35 miles unless the plan holder submits data to prove an alternative. If plan holders utilize the alternative then re-staging of existing equipment may be unnecessary.

The current cost of equipment required in the guidance is being incorporated into the proposed rules. The cost of the equipment is calculated by defining the share attributed to the state: subtracting the share of equipment required under the federal program and the state of Oregon requirements from the total equipment needed under the proposed rules. This state share is divided by the existing equipment to get a percentage share of equipment for boom, recovery, and storage devices. That percentage is then multiplied times the value of each type of equipment in the proposed rules. The value of the equipment is based on the total annualized value of each type of equipment taken from 2003-2004 survey data.

Table 1: Estimating the Weighted Share of Equipment Costs for the Proposed Rules

Equipment Basis for Shares	Boom	Removal	Storage	Weighted Share
Equipment Type Share of Cost	4.38%	38.05%	57.57%	
State Share of Total Capacity	35.29%	31.68%	19.95%	
State Share of Cost	1.55%	12.05%	11.48%	25.1%

The reported annualized cost of existing equipment required by the state is $7 million. The reported total annualized cost of existing equipment is $24 million. Taken as a whole, the existing caches of equipment in the state exceed the requirements of both federal and state requirements.

Existing rules as a baseline for drills

The existing rules called for one limited deployment and one unannounced full scale deployment drill each year. A limited deployment means a short term deployment of response equipment and people. An unannounced full scale deployment means all of the personnel and equipment necessary to show that the contingency plan is adequate to meet a worst case spill. This type of drill could theoretically last for several days and plan holders were to be chosen at random for participation.

The drill requirements could be partially met by deployment in actual spill responses. Response contractors could be excused from full deployment drills if, during a twelve month period, they had already satisfactorily drilled.

Since the initial development of the rules standard, the drill program evolved considerably in Washington. Actual practice in the drill program followed the guidance as discussed below and not this standard in the rules. Nonetheless, as described elsewhere in this document, the cost benefit analysis is looking at existing rules to proposed rules rather than using the guidance as a baseline.

***Guidance**: The state's drill guidance was modeled after the federal program and calls for two deployment drills and one tabletop drill each year. At least once every three years, the tabletop must be a worst case size drill. Unannounced tabletop and deployment drills called for by Ecology are conducted. Historically Ecology sponsored 1 to 3 unannounced drills per year. Plan holders are tested and then would not need to participate for another 3 years (except if plan deficiencies are found). These unannounced drills were not additional drills and could alleviate one or more of the required drills in a year. And the drill guidance required that "away team" members be mobilized in Washington once every 5 years for tabletop drills. Ecology staff evaluate the performance at drills and provide written comments on the effectiveness of plans as demonstrated at the drills.*

Federal rules as baseline for drills

The federal requirements are described in both rules and in guidance (the national preparedness and response exercise program). The standard for drills includes internal call-out procedure drills (4 each year); emergency procedure drills (4 each year); tabletop drills (1 each year, one every 3 years must be a worst case drill), deployment drills (2 each year); and unannounced drills called by the federal government. If a plan holder chooses to follow a different drill program, that program must equal or exceed these drills in type and frequency.

A significant difference between the state's drill program and the federal program is the written evaluation provided to the plan holder by the state. The federal program allows for self certification. There is a cost saving to plan holders for the paperwork in evaluating and tracking drill objectives provided by the state, which can be used to demonstrate compliance with the federal rules.

Anticipated change for drills by the proposed rules

The proposed rules closely follow the existing guidance. There is a new standard that twice in a three year period, a deployment drill must include the testing of a geographic response plan strategy. Unannounced drills will be conducted on an "as necessary" basis, and do not constitute an additional drill. The number of unannounced drills is expected to be no more than 2 per 3 year cycle for plan holders. The scope and frequency of tabletop and deployment drills under the new rules remains consistent with the federal requirements.

The following are areas where savings can be gained over the current rules:

- The tabletop drill: in 2 of the 3 years, the drill can be of a smaller scale than that required in the existing rules (full scale deployment).
- Plan holders can share credit for GRPs conducted by a response contractor. Only part of this is a savings as the existing rules used to allow spill responders to be excused from full deployment if they had already participated in a drill in the last year. Being excused was more general in the existing rules however; it did not allow the plan holder to simply take credit for its contractor's GRPs.
- Plan holders can get credit for drills conducted out-of-state.

The following are areas where costs can be greater over the current rules:

- The proposed rules require three drills per year instead of two.
- The revision requires that away team members be mobilized in Washington once every five years for a tabletop drill.
- The existing rules called for one limited deployment drill, though in practice two were conducted. The proposed rules require two deployment drills per year, or six in a three year cycle. Two of the six drills must deploy a GRP strategy; however plan holders can get credit for response contractors GRP drills.
- In the first triennial cycle an unannounced drill will have to survey, assess, verify, inspect or deploy response 50% of the resources listed in the plan. In the second triennial cycle, the other 50% of the resources will be addressed.

Again, it should be noted that the majority of these costs are not likely to truly be new since industry has been following the guidance for many years.

Current ongoing costs of drills and expected change

Reported costs for drills required by the state are approximately $3 million per year and costs for drills required by the federal program are about $1.5 million per year.

Much of this reported cost includes drills that were done out-of-state (while the fixed facilities conduct all of their drills in Washington, many of the vessel companies conduct their drills in Washington and other state). It is unclear what share of the costs of out-of-state drills should accrue to Washington since the drills were intended to meet both the requirements of either the federal government or another state, and often not the requirements of Washington's rules. Some respondents reported costs for unannounced drills that were not conducted in Washington and some reported participation in more drills than are required in Washington. This was particularly true of vessels. Ecology has been unable to remove many of these issues, thus the drill costs are probably overstated. Most changes should be cost neutral.

The largest cost change is created by dropping the requirement for each company to participate in a full-scale unannounced deployment drill every year. Ecology expects that these unannounced drills will be done in a more focused manner and each company should not need to participate in more than two out of every three years. These savings are prospective only. As the drill program evolved in the state, Ecology did not enforce the annual requirement for full-scale unannounced drills but instead practiced a more focused unannounced drill program. However it is the shift in the legal requirements that must be valued. Because they are not the norm, the data available on the cost of these drills is limited. The estimated savings for vessel companies is $45 thousand every third year or $15 thousand per year. The estimated savings for facilities is $11,000 every third year or $3,700. The estimated savings for the response contractors ranges from $3,000 (small response contractors) to $18,000 (large response contractors) per drill. The response contractors report billing less than this to their plan holders, so these costs may be included elsewhere in the contract, such as flat annual costs. An additional probable cost is imposed by an added limited deployment drill. These costs range from $4,000 to $8,000 per drill. These costs vary based on the company reporting.

The net effect for most vessels and some large facilities is a net reduction in costs. Response contractors should also see cost reductions. There is an expected small reduction in total existing drilling costs.

Training

Training is a critical component for preparedness and the benefits are great when team members train together in advance of a spill. The statute requires that plans incorporate periodic training programs and state the number, training preparedness, and fitness of personnel assigned to direct and implement the plan.

Existing rules as a baseline for training

The existing rules required that plans describe the type and frequency of spill response operations and safety training that each individual in a spill response position received to attain the level of qualification demanded by their job description, including safety training, training to minimize operational risks. The rules also stated that training records may be audited by Ecology.

***Guidance**: The guidance had more detail about the type of training appropriate to maintain a level of readiness.*

Federal rules as baseline for training

There are similar requirements under the federal rules.

Anticipated change for training by the proposed rules

The new rules require that plan holders commit to the training of personnel to implement the plan and continue to require that the plan describe the type and frequency of training that each individual listed in the plan receives. The key difference between the existing and new rules is the inclusion of a list of specific training topics: Incident Command System, Northwest Area Contingency Plan policies, use and location of Geographic Response Plans, the contents of the plan and worker health and safety as appropriate. There is also a requirement that new employees complete the training program prior to being assigned job responsibilities which require participation in emergency response situations. The new rules also allow the inspection of training records.

Current ongoing costs and expected changes in costs of training

Training costs under the current rules and current federal requirements are $4 million per year. This training would be necessary for either the state or the federal requirements and are therefore not a direct cost of the proposed rules. However, given that a share of the equipment used is required by the state and given that the federal government requires training on all equipment, the training is prorated over to the state and federal requirements based on shares of equipment.

Overhead costs

Overhead costs such as insurance and indirect costs associated with management under the current rules and the federal requirements are $3.4 million per year. This cost would be necessary for either the state or the federal requirements and should not change. They are therefore not a cost of the proposed rules.

Summary of compliance costs

The total cost of the state requirements under the proposed rules are approximately $6.8 million per year. Most of these costs are for equipment that is added to existing federal requirements or, for vessels navigating the Columbia River, existing Oregon requirements.

Table Costs 1: Annualized Costs

Items	**State Requirements**	
Planning		
Equipment Annualized	$	6,189,215
PRC & Letter of Agreement	$	2,372,322
Drill Costs	$	(229,710)
Training	$	918,912
Overhead	$	-
Other Costs	$	-
Total: Net out PRC Overlap*	$	6,878,417

6.0 Technical Analysis of Compliance Benefits

The benefits of preparedness and good contingency planning are many fold. Thoughtful planning leads to the ability to respond to a spill more rapidly, effectively and with appropriate resources. Damages from spills are minimized when responsible parties are trained and organized to respond. Preparedness also drives better awareness of spill risks and more investments in prevention. Rapid response and cleanup has two effects. The immediate cost of on water cleanup rises because of the pre-staging or resources, but that rapid response reduces the long term costs of shoreline cleanup, economic damages including penalties, and natural resource damages.

The following section uses the modeling method to calculate the probable benefits of the proposed rules. For more detail on the methodology used, refer to Appendix 9: Monte Carlo Simulation.

6.1 Society's Willingness to Pay

Oil spills are unacceptable to citizens. After the 1989 Exxon Valdez Oil Spill, comprehensive prevention and response laws were passed at the national and the state level. These laws targeted prevention and cleanup of spills and imposed liability for response and damages on the responsible parties (spillers pay). These included the Oil Pollution Control Act and state law. [2] The public's engagement on this issue is an indication of willingness to pay to avoid oil spills and willingness to pay to clean up after a spill. It is this value that Ecology has attempted to estimate in this report.

For example, a 1995 case study of willingness to pay to prevent spills on the California coast indicates the value placed on prevention at $76.45 per household.[3] The spills described in the study oiled 10 miles of coast and killed12,000 birds. By comparison, the scenarios studied for these rules involve similar lengths of coastline and up to 10 times the length. Estimated damages to shore birds for the scenarios studied for the rules are far higher. Therefore, the losses for the California study may be appropriate for the smaller, more frequent spills than for the worst case spills described in Washington law. [4]

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[2] RCW 90.56.010 Definitions. RCW 90.56.210 Contingency plans. RCW 88.46.010 Definitions. RCW 88.46.060 Contingency plans. RCW 90.56.060 Statewide master oil and hazardous substance spill prevention and contingency plan--Evaluation and revision or elimination of advisory committees.

[3] Valuing Oil Spill Prevention: A case study of California's Central Coast, Richard T Carson, Michael B. Conaway, W. Michael Hanemann, Jon A. Krosnick, Robert C. Michael, Stanley Presser, Kluwer Academic Publishers, 2004. Notes: This value must be indexed for inflation. There were a variety of exclusions. Eg. if the 15% of the respondents who objected that the oil companies should pay for the tug and not the citizens were excluded the results would have be $8.74 higher.

[4] RCW 90.56.010 Definitions. RCW 90.56.210 Contingency plans. RCW 88.46.010 Definitions. RCW 88.46.060 Contingency plans. RCW 90.56.060 Statewide master oil and hazardous substance spill prevention and contingency plan--Evaluation and revision or elimination of advisory committees.

The California scenario involved prevention and immediate response through the use of a tug escort. Thus the case study assumed 100% of spills would be immediately addressed for a 10 year period.

Applying this value to the oil removed after a spill implies a linear response to the amount of oil and that the respondents valued on water cleanup of 3 to 9 % of 10 years worth of oil spills in the same way they value 100% prevention of 10 years worth of oil spills. The formula must first net out the share of spill reduction attributable to the transfer rules. The formula is:

Value for 10 years = Average % Removal X Value for 100% removal X Number of Households

This generates a value that can be counted twice. Once for the first 10 years and again, but discounted, for the second 10 years. The total probable value is $16.5 million.

6.2 Benefit of Reduced Natural Resource Damages

Natural resource trustees determine whether damage to public trust resources from oil spills has occurred. Damage includes destruction of or loss of natural resources. Damages to natural resources are evaluated by identifying the functions or 'services' provided by the resources, determining the baseline level of the services provided by the injured resource(s), and quantifying the reduction in service levels as a result of the contamination. The measure of damages is the cost of restoring injured resources to their baseline condition, compensation for the interim loss of injured resources pending recovery, and the reasonable cost of a damage assessment. Trustees quantify injuries and identify possible restoration projects. Economic and scientific studies assess the injuries to natural resources and the loss of services. These studies are also used to develop a restoration plan that outlines alternative approaches to speed the recovery of injured resources and compensate for their loss or impairment from the time of injury to recover.
If we can reduce the amount of damage to the resources then we can reduce the damage assessment. Early response will likely reduce damage assessments for some areas of impact as the oil is removed prior to a wider spread impact. For further discussion of data, see Appendix 4: Review of Natural Resource Damage.

6.3 Benefit of Improved On-Water Removal[5]

One expected gain from the proposed rules is an increase in on-water removal before the oil impacts the shore and reducing the spread and creating greater resource damages. This reduction of impact is expected to be gained from the proposed rules requirement of early

[5] Most of the data for this section was taken from worst case spill scenarios for 65,000 and 25,000 barrel spills. *Evaluation of the Consequences of Various Response Options, Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters*, Deborah French-McCay, Jill Rowe, Nicole Whittier, Subbayya Sankaranarayanan and Claudia Suàrez, Applied Science Associates, Inc. Dagmar Schmidt Etkin, Environmental Research Consulting, 2005, 2006

deployment for protective boom and on-water recovery equipment. Based on modeling of some worst case spills, Ecology expects that between 0% and 19% more of a large spill could be removed. For further discussion, see Appendix 5: Benefits of Improved On-Water Removal.

6.4 Benefit of Reduce Shoreline Impacts

Under the proposed rules boom is tied directly to the GRP's and enhanced skimming needs. Boom arrives early and therefore shorelines, habitats and resources are protected and on-water recovery is enhanced. Shoreline protection is critical and the public is clear that these areas must be protected as soon as possible and before the oil hits. With early timeframes as called out in the proposed rules, deployment of booms for protection is probable. Another way to protect shorelines is greater on-water recovery. What oil is collected on water will not ultimately strand on the shorelines of the state.[6] Appendix 6 indicates the percentage reduction estimated by the modeling scenarios. In general, the modeled state requirements reduce the total shoreline impact 7% when compared with the federal requirements. In-situ-burning and dispersants also reduce shoreline oiled in the modeling scenarios. The average impact for the 3rd option in the modeled scenarios was to increase the shoreline oiling; however, this seems illogical and Ecology believes this is a limitation of the model. It is unrealistic to imagine that in the natural world more equipment deployed more rapidly would actually have this effect. For further discussion, see Appendix 6: Benefits of Reducing Shoreline Impacts.

6.5 Benefits of Reducing Environmental and Socioeconomic Cost of Spills

Oil spills impose environmental and socioeconomic losses. Socioeconomic losses accrue to industries as penalties, fishing, tourism, and shipping claims. Response costs including equipment and labor, shoreline cleanup costs, and less measurable losses to personal and public property, as well as foregone uses of natural resources for income or subsistence. Tribes may lose access to resources and subsistence fishing, parks and recreation, and tourism. Environmental damages create some of the socioeconomic losses, but some also stand alone. The deaths of shellfish, birds, fish, and mammals are a loss to society. The loss of habitat extends these losses over time. Some impacts from a spill can be avoided though rapid response. Other impacts occur quickly and response has little impact. The primary example of the latter is the toxic effects in the immediate areas exposed to a spill. This analysis deals with the probable avoidable damages. For further discussion, see Appendix 7: Benefits of reduce Environmental and Socioeconomic Cost of Spills.

[6] The data for this section of the document draws heavily on Evaluation of the Consequences of Various Response Options, Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters, Deborah French-McCay, Jill Rowe, Nicole Whittier, Subbayya Sankaranarayanan and Claudia Suàrez, Applied Science Associates, Inc. Dagmar Schmidt Etkin, Environmental Research Consulting, 2005, 2006.

6.6 Remainder Costs

The probable quantitative gains described above can be subtracted from the probable quantitative costs. The remaining net probable cost will provide a probable benefit in the event of a large spill, which cannot be predicted. The full cost impact of such a spill is likely to resemble the costs of other such spills. The costs of worst case spills dwarf the costs of the proposed rules. Being large, even with a high degree of preparation and planning, the spill will overwhelm capacity. In this case we will experience the smaller percentage gains from rapid response that is estimated in the modeling scenarios to capture, on average, 3% more of the spill on water.

6.7 Passive Use Losses

A 1992 contingent valuation study of lost passive use values resulting from the Exxon Valdez oil spill has been updated several times.[7] The revisions and indexing put the passive use value for American citizens at 11.0 billion in 2006 dollars. In the original study people were asked their willingness to pay to prevent a single such spill expected to occur within the original spill area only once in the next 10 years. One of the problems confronting the economists who analyzed the Exxon Valdez spill was that some survey respondents believed the spill was closer to Seattle.[8] Extrapolating this value to removal of oil in response to likely spills in Washington, it would then have a value of $110 million per 1% of all spills removed for a 10 year period. For a 3.2% reduction, this value would be over $600 million in a 20 year period.

In another case, a California passive use study which relied on payment by citizens within the state indicated a willingness to pay $76.45 per household. If this value were extrapolated to a 3.2% reduction in Washington spills through more effective on water recovery, and were paid for by the more limited population in this state, this would translate into a willingness to pay of $20 million.

Passive use is clearly an important component of what is lost in a spill. Decision makers must first decide whether it is appropriate to extrapolate from willingness to pay for prevention, to willingness to pay for improved on-water recovery. The next decision is whether it is appropriate to extrapolate a willingness to pay beyond the borders of Washington for this cleanup. If the answer to both these questions is yes, then the proposed rules is justified.

6.8 Stockholder Losses

In addition to payouts by the responsible party, there are stock losses both for that company and the other companies in the industry. This can be accompanied by reduced

[7] Literature discussion on both passive use studies in: Evaluation of Probable Costs and Benefits of Proposed Oil Transfer Rules, Entrix, 2006.
[8] On Designing Constructed Market in Valuation Surveys, Robert Cameron Mitchell, Environmental and Resource Economics, June 2002, 22, pgs 279-321.

demand for the product of an identifiable company.[9] When the Exxon Valdez spill occurred, the stock holders lost between $4.7 and $11.3 billion dollars.[10] But the industry as a whole experienced losses half again as large as Exxon alone. Further, the poor response pattern and final damages had an effect that was almost as large as the losses generated at the first news of the spill.[11] These losses were as large if not larger than the cleanup costs and damages alone. Summing all losses together, one has a value of over $2,000 per gallon. See Appendix 8: Stockholder Losses.

If a large spill took place in the Columbia River, the Strait of Juan de Fuca, or Puget Sound there is a potential for a similar response.[12] We see this response in much smaller spills than a worst case volume. Given the larger neighboring population, the economic damages would be higher and possibly the press visibility would be greater. On the other hand, the Exxon Valdez was the first major spill of its kind and the industry and stockholders woke up to the liability and demand damage potential. To some extent the shock of this reckoning is already included in current market prices.

Stockholder losses cannot be extrapolated to small spills. Further, it is hard to say whether public perception would be altered by the additional capital and effort that would be brought to bear immediately due to the proposed rules. Certainly it would be more helpful than the poor response pattern for the Exxon Valdez spill.

Stock and demand impacts are important to larger companies and to individuals and companies that are holding their stock. The total losses may also include political shifts as part of the fallout from a large spill. In the case of the Exxon Valdez, changes in tax status and lack of access to oil field drilling areas transferred wealth from one set of people to another set. Taxes shift wealth in the present. Postponing oil exploration postpones economic gains and environmental losses, transferring them to a future generation. Large companies may therefore have different incentives than small companies as they view the costs of these proposed rules. Thus if a small company had a large spill, this value would not necessarily accrue.

[9] Estimating the Costs of the Exxon Valdez Oil Spill, Johnathan D. Jones, Christopher L. Jones, and Fred Phillips-Patrick, Research in Law and Economics, 1994, Volume 16, 109-149, JAI Press Inc. Pg 129 Industry losses were 16.8 billion where Exxon's losses were estimated at $11.3 billion. 18,000 people sent in their Exxon credit cards.
[10] ibid pg 134.
[11] Ibid On page 129 Exxon's CAR (cumulative abnormal return) after the first news came out was -.107. The final CAR was -1.97 5 months later, as the level of damage became apparent. The same relative values for the oil industry as a whole were -.041 and -.084 or approximately double.
[12] One of the problems confronting the economists who analyzed the Exxon Valdez spill was that some survey respondents believed the spill was closer to Seattle. Pg 306. On Designing Constructed Market in Valuation Surveys, Robert Cameron Mitchell, Environmental and Resource Economics, June 2002, 22, pgs 279-321.

Summary of Compliance Benefits

The total estimated benefits for the rules depend to an extent on whether it is reasonable to expect a major oil spill. Probable benefits extrapolated to the general range of spills are dwarfed by such an incident. The probable quantitative benefits are $40 million without a 65,000 barrel spill and $240 million if one occurs and that spill has similar ramifications as those of the Exxon Valdez spill.

Extrapolating passive use values from a prevention study to a cleanup study, then those probable quantitative benefits would range from $20 million to $159 million.

If all the costs of the proposed rules were borne by Washington citizens, then each household would be paying an average of $3. Decision makers need to decide whether they believe that Washington households are willing to pay an average of $3 per year in order to maintain readiness at current levels.

Least Burden Determination

The proposed rules are both less burdensome for businesses and provide greater net benefits than various options considered in this rule making. The following are areas where savings can be gained over the current rules:

- No requirement to create a system for categorizing spills by size and type.
- No requirement to create a scenario for small and worst case spills.
- Allowing a reference to the Northwest Area Contingency Plan (NWACP) for environmental sensitivities (GRPs), disposal plan, ICS job descriptions, ICS process, and description of the relationships with other plans.
- Create a single plan for both federal and state requirements. Encouraging the development of umbrella plans where costs can be shared.
- No requirement to describe the response methods to clean up oil in various environments. Reference to the NWACP takes care of this requirement. Savings are gained by planning at the regional level, rather than requiring plan holders to meet this requirement individually.
- Equipment lists may be referenced from the response contractor applications or the Regional Equipment list Web site.
- No requirement to describe and include the communication systems the plan holder will use.
- Storage requirements maintained at the existing level, except at transfer locations and for pipeline companies. Allowing 50% of storage requirements to be met through shoreside facilities.

Appendix 1: Crosswalk of existing laws

This table represents a simplification of the various regulatory standards and contains assumptions about oil type, spill size and facility type. B=4X means 4X length of vessel, S=2X means twice the recovery rate.

Federal Standards	**1 hr. at transfer locations**	**2 hr. at transfer locations**	**6 hr.**	**12 hr.**	**24/30 hr.**	**36 hr.**	**48/54 hr.**	**60/72 hr.**
High Volume Port	AMPD	AMPD	Tier 1 = 15%		Tier 2 = 25%		Tier 3 = 40%	
Vessel	B= 2,000 feet	R=50K, S=100K		B=30K R=12.5K S=25K		B=30K R=25K S=50K		B=30 R=50K S=100K (60 hrs)
Facility	B= 2,000 feet	R=50K, S=100K	B =30K R =12.5K S=25K		B=30K R =25K S=50K (30 hrs)		B=30 R=50K S=100K (54 hrs)	
Non High Volume Port								
Vessel	B= 2,000 feet	R=50K, S=100K			B=30K R=12.5K S=25K (24 hrs)		B=30K R=25K S=50K (48 hrs)	B-30 R-50K S-100K (72)
Facility	B= 2,000 feet	R=50K, S=100K		B=30K R=12.5K S=25K		B =30K R=25K S=50K		B=30 R=50K S=100K (60 hrs)
Oregon Standards	**1 hr. Resident**	**2 hr. Resident**	**6 hr. Resident or Adjacent**	**12 hr.**	**24 hr.**	**48 hr.**		
Facility on Columbia River	B=4X	B=8X	R=10% or 12,000 bbls S=3X	B=35,000 or 15,000 non-persistent R=15% or 36,000 bbls S=3X	Boom as needed, R=20% or 48,000 bbls S=3X	R=25% or 60,000 bbls S=3X		
Vessels in Subzones 2, 3, 4	N/A	1000 feet on-site, 4X available	B=10,000 feet, R=2% or 12,000 bbl S=3X	B=40,000 feet, R=5% or 36,000 bbls S=3X	boom as needed 12% or 48,000 bbls S=3X	R=17% or 60,000 bbls S=3X		
Old Rule OR/WA	**1 hr.**	**2 hr.**	**6 hr.**	**12 hr.**	**24 hr.**	**48 hr.**	**72 hr.**	
Facility	B=4X	B=8X	R=10% or 12,000 bbls S=1X persistent, 5X non persistent	B=10 or 30,0000 R=15% or 36,000 bbls S=1X persistent, 5X non persistent	R=20% or 48,000 bbls S=1X persistent, 5X non persistent	R=25% or 60,000 bbls S=1X persistent, 5X non persistent		
Pipelines	case by case determination		R=10% or 12,000 bbls S=1X persistent, 5X non persistent	B=10,000 or 15,000 R=10% or 12,000 bbls S=1X persistent, 5X non persistent	Boom as needed R=20% or 48,000 bbls S=1X persistent, 5X non persistent	R=25% or 60,000 bbls S=1X persistent, 5X non persistent		
Vessels		B=4X overflight assessment for outer coast	B=10 or 20K, R=2% or 12000 S=1X	B=40,000 feet, R=3-5% or 36,000 bbls S=1.5X	boom as needed 12% or 48,000 bbls S=2X	R=17% or 60,000 bbls S=2-3X	R=20% or 72,000 bbls S=must keep up	

Appendix 1: Crosswalk of existing laws continued

New WA Proposed Rule	1.5 hr.	2 hr.	3 hr.	6 hr.	12 hr.	24 hr.	48 hr.	
Transfer locations	in oil transfer rule	in oil transfer rule		10000 feet 10% or 12,500 bbls S=2X	Additional 40,000 feet 15% or 36000 bbls S=2X	Boom as needed 20% or 48,000 S=3X	25% or 60000 bbls S=as needed	
Transit locations			boat, 1000 boom	Additional 10,000 feet 3% or 12,000 bbls S=1X	Additional 20,000 feet 10% or 36,000 bbls S=1.5	Additional 40,000 feet, 14% or 48,000 bbls S=2X	25% or 60,000 bbls	
Transmission pipelines	assessment	Boom use formula or 2000 feet		5000 feet 10% or 12,000 bbls S=1X	Additional 20,000 feet 15% or 36,000 S=2X	Boom as needed 20% or 48,000 S=3X	25% or 60000 bbls S=as needed	
San Juan		boat, 1000 feet boom. Resident	Additional 2,000 or 4X. Resident	Additional 10,000 feet 3% or 12,000 bbls S=1X	Additional 20,000 feet 10% or 36,000 bbls S=1.5	40,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Padilla Bay	boat, 1000 feet boom	Additional 2,000 or 4X		Additional 10,000 feet. 3% or 12,000 bbls, 50% in shallow water S=1X	Additional 20,000 feet 10% or 36,000, 20% in shallow water S=1.5	Additional 40,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Commencement Bay	boat, 1000 feet boom	Additional 2,000 or 4X		Additional 10,000 feet 3% or 12,000 bbls S=1X	Additional 10,000 feet 10% or 36,000 bbls S=1.5X	Additional 40,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Nisqually		boat, 1000 boom	Additional 2,000 or 4X	Additional 12,000 feet 2,400 calm water - current. 3% or 12,000 bbls, 50% in shallow water S=1	Additional 10,000 feet 1000 calm water - current. 10% or 36,000 bbls 50% in shallow water S=1.5	Additional 20,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Dungeness		boat, 1000 boom	Additional 2,000 or 4X	Additional 7,000 feet 3,000 feet open water. 3% or 12,000 bbls, 50% in open water S=1X	Additional 10,000 feet 10% or 36,000 bbls 50% open water S=1.5X	Additional 20,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Neah Bay		boat, 1000 boom resident	Additional 2,000 or 4X resident	Additional 6000 feet 4000 open water 3% or 12,000 bbls 100% open ocean resident S=1X resident	Additional 10,000 feet 10% or 36,000 bbls 60% open water S=1.5X	Additional 40,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Copalis		boat, 1000 boom	Additional 2,000 or 4X	Additional 12,000 feet 6,000 feet open water. 3% or 12,000 bbls 100% open water S=1X	Additional 10,000 feet 10% or 36,000 bbls 60% open water S=1.5X	Additional 20,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Grays Harbor		boat, 1000 boom	Additional 2,000 or 4X	Additional 6000 feet 1000 feet open water 3000 calm water current. 3% or 12,000 bbls 25% shallow water S=1X	Additional 10,000 feet 10% or 36,000 bbls 50% open water, 25% shallow water S=1.5X	Additional 40,000 feet, 14% or 48,000 bbls S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Willapa		boat, 1000 boom	Additional 2,000 feet of boom, or 4 times	Additional 10000 feet 6000 calm water current. 3% or 12,000 bbls 10% shallow water S=1X	Additional 10,000 feet 1000 calm water current. 10% or 36,000 bbls 50% open water 25% shallow water S=1.5X	Additional 40,000, 14% or 48,000 bbls, S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Lewis and Clark		1000 feet with boat	Additional 2,000 or 4X	Additional 7,000 feet 4,200 feet calm water - current 3% or 12,000 bbls 10% shallow water S=1X	Additional 10,000 feet, 5,000 calm water - current 10% or 36,000 bbls, 25% open water, 25% shallow water S=1.5X	Additional 40,000, 10,000 calm water - current. 14% or 48,000 bbls, 25% open water S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
Ridgefield		1000 feet with boat	Additional 2,000 or 4X	Additional 6000 feet 3000 calm water current. 3% or 12,000 bbls 10% shallow water S=1X	Additional 10,000 feet, 5,000 feet of calm water - current capable.10% or 36,000 bbls, 25% shallow water S=1.5	Additional 40,000, 10,000 calm water - current. 14% or 48,000 bbls, S=2X	Boom as needed 25% or 60,000 bbls S= as needed	
McNary		1000 feet with boat	Additional 2,000 or 4X	Additional 8000 feet 3000 calm water current. 3% or 12,000 bbls 10% shallow water S=1X	Additional 10,000 feet, 5,000 feet of calm water - current capable. 10% or 36,000 bbls, 25% shallow water S=1.5X	Additional 40,000, 10000 calm water - current. 14% or 48,000 bbls, S=2X	Boom as needed 25% or 60,000 bbls S= as needed	

Appendix 2: Market Structure

Spill liability and spill publicity has had an impact on market structure. This affects spill preparedness and response.

Liability, Costs and Internalization

Spills can create damages that are substantial. OPA and CERCLA at the federal level and Washington State law make the responsible party liable in the event of a spill. The ideas of internalizing external costs and making the public whole again form the logical basis for liability. In theory, if the costs are internal to the company, then the company itself will expend an optimal amount of their resources on preventing and responding to a spill. Given that they know the magnitude of the potential loss and the nature and efficacy of the safety equipment and personnel who would prevent a spill, long term profit maximization should yield a rational decision. Further, in the event of a spill the public will be made whole.

Bankruptcy may prevent liability from working. An unintended consequence is the downsizing of companies to limit liability. The responsible party may or may not have sufficient resources to provide for cleanup and restoration, and cover the interim damages. The level of damage may be larger than the present value of all future net income for the company. Bankruptcy will limit claims against the company. Mac Minn[13] finds that the value of shareholder stock can be increased at the expense of potential liability claimants by spinning off high risk parts of the company into separate smaller companies, still owned by the shareholders. The value of this spin off gain to the shareholders is the cost of stop loss type insurance.

Given that some companies we are now regulating may have been created in such a move, the proposed rules force them to re-internalize the risk reduction they might already have taken if they had remained part of the larger company. Ringleb and Wiggins[14] found that there was a 20% increase in the number of small firms in the economy driven in part by the strict liability for tort claims. There is some indication that this may have taken place in Washington. Over the period of the 1970s and 1980s vertically integrated shipments to refiners fell from 35% (1972) to 15% (1993).[15] During the same period spills were rising.

With respect to tonnage of oil tanker shipments, the opposite has been true in the 1990s. It is possible that this is due to a combination of the change in the magnitude of possible losses, "vicarious liability" and the responsibility of large corporations for the actions of contractors. Between 1989 and 1992 the percentage of oil shipped by major oil

[13] Corporate Spin-Offs as a Value Enhancing Technique when Faced with Legal Liability, Richard D. MacMinn, Patrick L. Brockett, Insurance Mathematics and Economics, 1995, (16) pgs. 63-68.
[14] Liability and Large-Scale, Long-Term Hazards, Journal of Political Economy, 1990, (98) pgs. (ON ORDER)
[15] Liability and Organizational Choice, Richard Brooks, Journal of Law and Economics, 2002, 45(1), pgs. 91-125, pg. 99.

companies increased from 28% to 67%.[16] Majors also increased their share of shipments of gasoline and distillates. In addition the share of U.S. flagged tankers increased from 31% to 42%.[17]

Many companies reported concerns about costs 10 years ago when Ecology was first implementing the financial responsibility requirements of Chapter 88.40 RCW. For example, one company interviewed in 1993,[18] had recently purchased an older tank facility from a major company. They had not factored in the cost of either the spill control mechanisms or insurance when they bought the facility. They had been told the company was selling the tank because it was an older tank. Thus they bought the liability and risk with the facility.

All the legal requirements built into the law in the early 1990s, insurance, preparedness, and prevention requirements seek to prevent companies from externalizing the risk and giving the liability back to the public at large. The requirement of having the plans and relationships required in the proposed rules then means that the companies to some extent prepay for the risk they impose.

The prior shareholders of large companies have already experienced the gains of externalizing the potential losses. The small companies generated by this externalization process will, under the proposed rules, have to re-internalize the risks that others have avoided. Given this, the cost of the type of rules on this type of industry is even more likely to impose disproportionate impacts than a typical rule in a typical sector.

[16] Liability and Organizational Choice, Richard Brooks, Journal of Law and Economics, 2002, 45(1), pgs. 91-125, pg. 111.
[17] Ibid. pg. 112-113.
[18] Small facility interviewed in spring of 1993 during research on the financial responsibility rule.

Appendix 3: Codes from Final Report

Evaluation of the Consequences of Various Response Options, Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters

Location	Response	Mechanical Removal	Dispersant Included	ISB	Abbreviation
Outer Coast	1-NOREM				OC-Crud-N
Outer Coast	2-MECHST	*			OC-Crud-R-ST
Outer Coast	2-MECHFED	*			OC-Crud-R-Fed
Outer Coast	2-MECH3RD	*			OC-Crud-R-3
Outer Coast	2- ISB	*		*	OC-Crud-R-ISB
Outer Coast	3- DISP MECHST	*	*		OC-Crud-C-ST
Outer Coast	3- DISP MECHFED	*	*		OC-Crud-C-Fed
Outer Coast	3- DISP MECH3RD	*	*		OC-Crud-C-3
Strait of Juan de Fuca	4-NOREM				S1-Bunk-N
Strait of Juan de Fuca	4-MECHST	*			S1-Bunk-R-ST
Strait of Juan de Fuca	4-MECHFED	*			S1-Bunk -R-Fed
Strait of Juan de Fuca	4-MECH3RD	*			S1-Bunk -R-3
Strait of Juan de Fuca	4-ISB	*		*	S1-Bunk-R-ISB
Strait of Juan de Fuca	5-NOREM				S1-Dies-N
Strait of Juan de Fuca	5-MECHST	*			S1-Dies-R-ST
Strait of Juan de Fuca	5-MECHFED	*			S1-Dies-R-Fed
Strait of Juan de Fuca	5-MECH3RD	*			S1-Dies-R-3
Strait of Juan de Fuca	6-NOREM				S2-Crud-N
Strait of Juan de Fuca	6-MECHST	*			S2-Crud-R-ST
Strait of Juan de Fuca	6-MECHFED	*			S2-Crud-R-Fed
Strait of Juan de Fuca	6-MECH3RD	*			S2-Crud-R-3
Strait of Juan de Fuca	6-ISB	*		*	S2-Crud-R-ISB
Strait of Juan de Fuca	7-DISP MECHST	*	*		S2-Crud-C-ST
Strait of Juan de Fuca	7-DISP MECHFED	*	*		S2-Crud-C-Fed
Strait of Juan de Fuca	7-DISP MECH3RD	*	*		S2-Crud-C-3
San Juan Islands	8-NOREM				SI-Crud-N
San Juan Islands	8-MECHST	*			SI-Crud-R-ST
San Juan Islands	8-MECHFED	*			SI-Crud-R-Fed
San Juan Islands	8-MECH3RD	*			SI-Crud-R-3
San Juan Islands	9-DISP MECHST	*			SI-Crud-C-ST
San Juan Islands	9-DISP MECHFED	*			SI-Crud-C-Fed
San Juan Islands	9-DISP MECH3RD	*			SI-Crud-C-3
Inner Str/Puget Sound	10-NOREM				IS-Crud-N
Inner Str/Puget Sound	10-MECHST	*			IS-Crud-R-ST
Inner Str/Puget Sound	10-MECHFED	*			IS-Crud-R-Fed
Inner Str/Puget Sound	10-MECH3RD	*			IS-Crud-R-3
Inner Str/Puget Sound	11-DISP MECHST	*	*		IS-Crud-C-ST
Inner Str/Puget Sound	11-DISP MECHFED	*	*		IS-Crud-C-Fed
Inner Str/Puget Sound	11-DISP MECH3RD	*	*		IS-Crud-C-3
Lower Columbia River	12-NOREM				C1-Bunk-N
Lower Columbia River	12-MECHST	*			C1-Bunk-R-ST
Lower Columbia River	12-MECHFED	*			C1-Bunk-R-Fed

Lower Columbia River	12-MECH3RD	*			C1-Bunk-R-3
Upper Columbia River	13-NOREM				C2-Bunk-N
Upper Columbia River	13-MECHST	*			C2-Bunk-R-ST
Upper Columbia River	13-MECHFED	*			C2-Bunk-R-Fed
Upper Columbia River	13-MECH3RD	*			C2-Bunk-R-3

Appendix 4: Review of Natural Resource Damages

Introduction

The purpose of this appendix is to estimate the relationship between Natural Resource Damage Assessment (NRDA) awards and the total amount of light or heavy oil spilled on water. This document shows this relationship based on the currently available data. Ecology will accept additional data during the comment period. Specifically, better data on light oil spills is needed.

Data Overview and Analysis

For this analysis, data was collected from numerous on-line sources. Data collected consists of: spill name, spill location, date of the spill, amount of substance spilled, type of substance and NRDA cost. Spills ranged from 25 gallons to millions of gallons. Only spills with NRDA data were considered. Spills took place from 1984 to 2005. Most data was collected from government sources. All the cost data was converted to 2006 dollars using the CPI[19]. The majority of the spills were small, which makes sense since the probability of a large spill such as Exxon Valdez repeating in a single year is low (refer to Probability of large spill.xls[20]). The data used in this analysis is constrained by numerous factors, which should be taken into account while interpreting the resulting statistics.

• Sample size: The number of spills is limited. NRDA cost information is difficult to find, many spill cases have been settled out of court keeping the information private. Responsible parties are not obligated to disclose cost information.

• Human error and rounding: Even though most of the spill data was found on government websites, the possibility of human error and omission is possible. Some spill quantities or NRDA costs were rounded (when comparing different sources).

• Conversion inaccuracies: Some spills only had "barrels spilled" information, which needed to be converted to gallons spilled. A standard 42gallons/barrel[21] multiplier was used. Also, annual average CPI indexes were used, which might have had slight variation from monthly indexes.

• Data limitations: Data on the context of most spills is limited. Analysis was only done on the spill size, NRDA cost and NRDA/g cost. This analysis does not directly take into account if the spill occurred in an ecologically sensitive area which had endangered species or not, the percent of the oil successfully cleaned up on the water, or the level of cleanup mounted.

• Consistency of NRDA costs with time: Some of the spills in the data sample occurred in the early 80's and some in the mid 90's. The change of procedures in the NRDA and oil

[19] ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt
[20] Probability of large spill.xls
[21] http://en.wikipedia.org/wiki/Barrel

spill response over time can have an effect on costs. This effect is not accounted for in the analysis. Therefore, the analysis presented should only be considered as illustrating broad trends.

Ecology selected spills that met the following criteria for analysis:
• Spills which occurred in the United States.
• Spills which had available data for NRDA.
• Spills which could be distinguished by location and type of material spilled.

After filtering through all the data[22], 101 spills[23] remained for analysis (74 spills were left out). These 101 spills were used to generate 14 variables[24] (east coast spill, west coast spill, heavy oil, light oil, quantity of light oil, quantity of heavy oil, total quantity of oil, NRDA costs, NRDA per gallon costs, and also natural logs of the previous five categories). Natural log of NRDA was regressed on the natural log of quantity of oil spilled (See Table I for the results of the regression). All the results from the regression came back statistically significant.

Using the results from the regression two equations was derived. One equation was used to estimate NRDA, and the other equation was used to estimate NRDA/g.

• 1. NRDA equation:

$$y = 14.4220094 * x^{.996198689}$$

Where y = NRDA, x = quantity of oil.

• 2. NRDA/gallon equation:

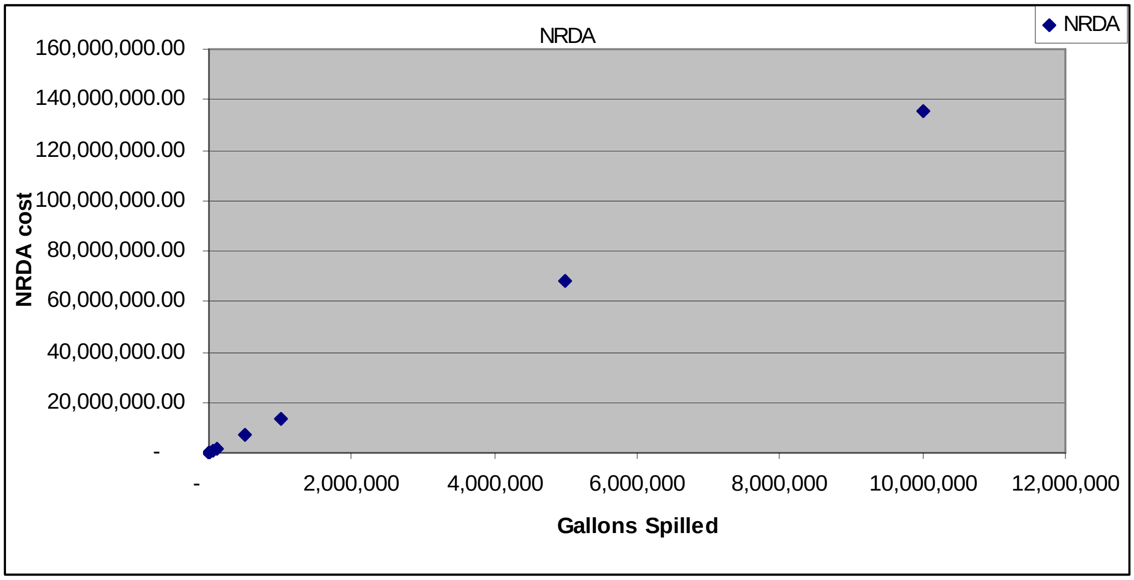
$$y = 14.220094 / x^{.003801311}$$

Where y = NRDA/g, x = quantity oil.

Using equation 1, the following graph can be calculated.

[22] CompiledData.xls, SpillInfo.xls
[23] CompiledData.xls
[24] CompiledDataAnalysisUpdate.xls

Graph 4.1. NRDA.

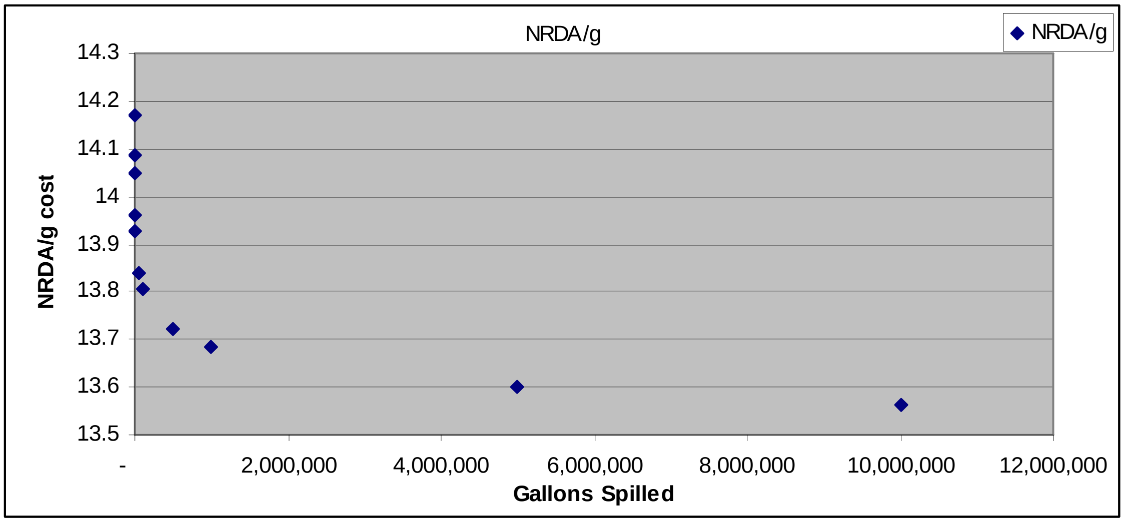


The oil quantities used can be found in Table II a.

This table demonstrates that as more oil is spilled, the higher the NRDA cost. The NRDA increase is almost linear in the graph. As the size of the oil spill increases, the NRDA cost increases, but at a diminishing rate. This diminishing rate is low, allowing the relationship to look linear. The maximum spill size for this data was 12,000,000 gallons, and the regression should not be viewed as valid beyond this value because there are no real data points in the sample to compare results with.

Using equation 2, for heavy oil, the following graph can be calculated:

Graph 4.2. NRDA/g.



The oil quantities used can be found in Table II b.

This graph demonstrates that as more oil is spilled, the NRDA/g cost decreases. As you can see on the graph, there is a rapid decrease in NRDA/g costs with low amounts of oil spilled, and then a slower decrease in NRDA/g costs with larger spills. The maximum spill size for this data was 12,000,000 gallons, and the regression should not be viewed as valid beyond this value because there are no real data points in the sample to compare results with.

Model Validity

The results that were provided by the regression were statistically significant. The R squared residual was .86. R Squared is the relative predictive power of a model as measured by explained variance. R squared is a descriptive measure between 0 and 1. The closer it is to 1, the greater your ability to predict. The t-statistic came up significant for both variables: 8.04 and 24.73. The F statistic was 611.55 and significance f (also known as the p-value) was 3.67178E-44, which means the model was significant.

Conclusion

The data used in this analysis is constrained by numerous factors, previously listed, which should be taken into account while interpreting the resulting statistics. Therefore, the analysis presented should only be considered as illustrating broad trends. The analysis performed shows that as the quantity of spills increase, the NRDA increases almost linearly with a slight diminishing rate. The analysis also shows that as the quantity of spills increase, the NRDA/g costs decrease at a diminishing rate.

Table 4.3: NRDA Compensation Schedule Cost Summary

NRDA Compensation Schedule Cost Summary			Index		
Based on spill scenario areas and selected spills			1.586124402		
Eliminated spills with high Canadian exposure			2005 dollars		
Assumes 5% shoreline and 95% open water for the calculations					
Outer Coast - Crude			Mid Straits - Diesel		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$57.21	0.517576%	Spring	$36.04	0.256291%
Summer	$54.12	0.517076%	Summer	$29.09	0.253812%
Fall	$50.77	0.516466%	Fall	$27.01	0.252821%
Winter	$53.78	0.517018%	Winter	$28.74	0.253654%
Outer Coast - Bunker			Inner Straits - Crude		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$74.62	0.396867%	Spring	$51.62	0.516559%
Summer	$70.61	0.396320%	Summer	$47.83	0.515785%
Fall	$66.27	0.395653%	Fall	$43.07	0.514623%
Winter	$70.17	0.396257%	Winter	$43.90	0.515191%
Outer Coast - Diesel			Inner Straits - Bunker		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$45.91	0.258032%	Spring	$67.38	0.395786%
Summer	$43.46	0.257546%	Summer	$62.47	0.394943%
Fall	$40.82	0.256955%	Fall	$56.31	0.393679%
Winter	$43.20	0.257490%	Winter	$57.37	0.394232%
Outer Straits - Crude			Inner Straits - Diesel		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$48.65	0.516198%	Spring	$41.49	0.257092%
Summer	$47.88	0.516034%	Summer	$38.50	0.256347%
Fall	$45.62	0.515525%	Fall	$34.74	0.255232%
Winter	$42.00	0.514595%	Winter	$35.38	0.255679%
Outer Straits - Bunker			San Juan Islands - Crude		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$63.53	0.395305%	Spring	$50.16	0.516478%
Summer	$62.53	0.395125%	Summer	$45.62	0.515498%
Fall	$59.60	0.394567%	Fall	$40.84	0.514232%
Winter	$54.91	0.393548%	Winter	$43.90	0.515191%
Outer Straits - Diesel			San Juan Islands - Bunker		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$39.15	0.256612%	Spring	$65.48	0.395646%
Summer	$38.54	0.256452%	Summer	$59.60	0.394575%
Fall	$36.75	0.255956%	Fall	$53.41	0.393193%
Winter	$33.89	0.255053%	Winter	$57.37	0.394232%
Mid Straits - Crude			San Juan Islands - Diesel		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$44.76	0.515849%	Spring	$40.33	0.256937%
Summer	$35.96	0.513287%	Summer	$36.75	0.255987%
Fall	$33.32	0.512256%	Fall	$32.97	0.254765%
Winter	$35.51	0.513123%	Winter	$35.38	0.255679%
Mid Straits - Bunker			Upper Columbia River (near Portland to Longview)		
	$/gal	% cost reduction per 1% recovery		$/gal	% cost reduction per 1% recovery
Spring	$58.47	0.394935%	Crude	$22.90	0.526316%
Summer	$47.07	0.392134%	Bunker	$29.65	0.406504%
Fall	$43.65	0.391010%	Diesel	$18.08	0.266667%
Winter	$46.49	0.391954%			

Table 4.4 Regression: in NRDA vs. in Quantity

Regression Statistics	
Multiple R	0.927723881
R Square	0.8606716
Adjusted R Square	0.859264242
Standard Error	1.441914386
Observations	101

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1271.487125	1271.487125	611.551474	3.67178E-44
Residual	99	205.8325925	2.079117096		
Total	100	1477.319717			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%
Intercept	2.66875547	0.332107615	8.035815344	2.01156E-12	2.009781927
ln Quantity	0.996198689	0.04028371	24.7295668	3.67178E-44	0.916267071

Upper 95%	Lower 95.0%	Upper 95.0%
3.327729013	2.009781927	3.327729013
1.076130306	0.916267071	1.076130306

NRDA- Table II a

y =	14.4220094	* x^.9962
x	NRDA	
100	1,417.17	
500	7,042.65	
1,000	14,048.24	
5,000	69,812.77	
10,000	139,258.12	
50,000	692,043.72	
100,000	1,380,445.35	
500,000	6,860,128.01	
1,000,000	13,684,152.55	
5,000,000	68,003,444.14	
10,000,000	135,648,999.76	

NRDA/g Table II b

y =	14.4220094	/x^.0038
x	NRDA/g	
100	14.17173921	
500	14.08530155	
1,000	14.04823749	
5,000	13.96255311	
10,000	13.92581205	
50,000	13.84087438	
100,000	13.8044535	
500,000	13.72025603	
1,000,000	13.68415255	
5,000,000	13.60068883	
10,000,000	13.56489998	

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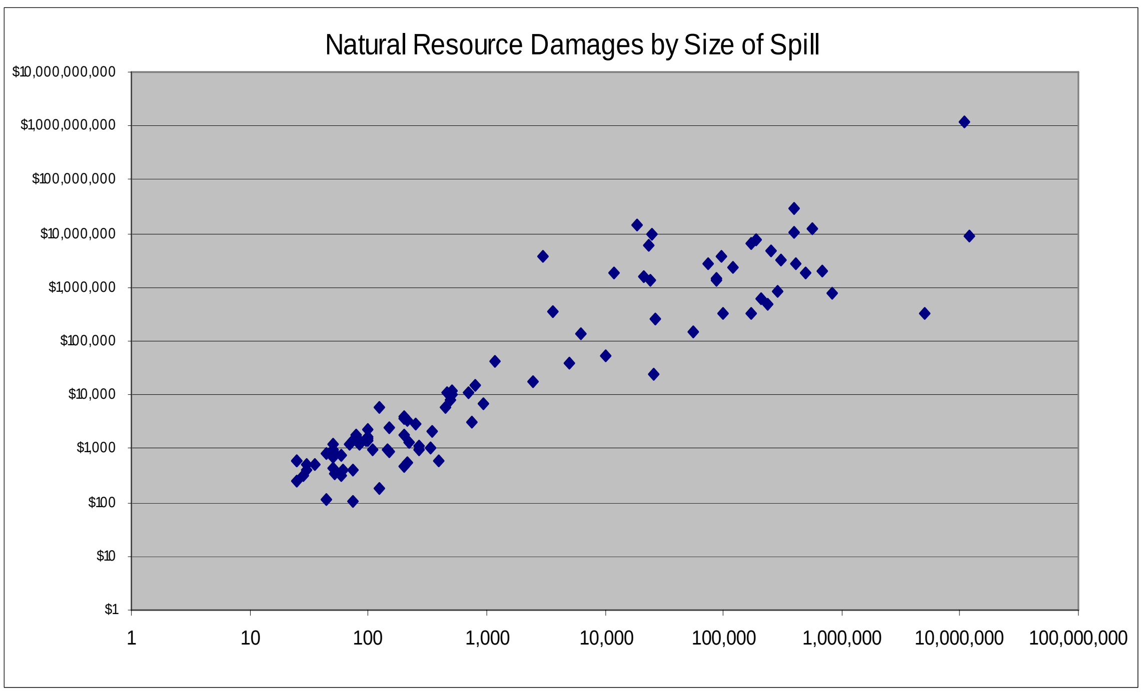
Benefits of Reducing Natural Resource Damages

Natural resource damages are a fairly orderly increasing function of the quantity of oil spilled. Graphic 4.4 NRDA displays raw data on 100 cases on a log/log graph. From here it is clear that both the natural resource damage assessments themselves and the variance in the resource damages increase with the gallons spilled. Thus the range of NRDA values per gallon for smaller spills varies from one order of magnitude for small spills to 4 orders of magnitude for large spills. Given this, the NRDA for any given hypothetical large spill is difficult to estimate other than to say it is probably not larger than $1000 per gallon and probably not lower than $1 per gallon. On the other hand work completed by Environmental Research Consulting and other sources suggest that the total costs for the use values of marine ecosystems damaged by oil spills range from $1 per gallon to over $4,000 per gallon spilled.[25]

Graphic 4.4: Natural Resource Damages by Quantity of Oil Spilled



This data covers the range of environmental damage values provided by Table 7.1 and 7.2 and provides additional support for using the values in the Environmental and Socioeconomic section.

For smaller spills Washington uses Chapter 173-183 WAC to calculate the cost per gallon. Ecology staff has used the scenario spills to estimate the NRDA effects of

[25] Evaluation of Probable Costs and Benefits of Proposed Oil Transfer Rules, Entrix, Extrapolated from "Comments on *Draft 2003 Report to Congress on the Costs and Benefits to Federal Regulation*", (Federal Register, Vol. 68, No. 22, pp. 5492-5527).

increasing the removal of oil by 1%. The average impacts are presented in table 4.3. The values generated are within the range of the graphic above and also tend to indicate that additional removal of oil on water not only reduces the total gallons to which the NRDA rate per gallon is applied, it also on average reduces the NRDA rate. The values in the table have been indexed to 2005. They are comparable but somewhat lower than the environmental damage estimates in Appendix 7.

NRDA Data References:

1. EstimatedDataNotCoveredCharts25gak.xls - Dagmar Schmidt Etkin's data with Washington spills starting at 25 gallons.
2. ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt - Consumer Price Index historical data.
3. http://www.darrp.noaa.gov/library/pdf/costsofs.pdf (p.21-22) - spill info for some of the spills.
4. http://www.uscg.mil/hq/g-m/nmc/gendoc/coop.pdf (p.14) - Nautilus NRDA information.
5. http://www.astswmo.org/Working%20Folder%20with%20Publications%20-%20Sept.%2026%202005/nrdsur.txt - Presidente Rivera NRDA info.
6. http://fs1.fbo.gov/EPSData/DOC/Synopses/3055/50-DSNC-1-90013/CvrLtrtoAmend001-90013.pdf - World Prodigy NRDA info.
7. http://en.wikipedia.org/wiki/Barrel - conversion data for gallons per barrel of oil.
8. http://www.dfg.ca.gov/ospr/organizational/scientific/nrda/NRDA.htm - links to the California NRDA and spill data.
9. http://www.prbo.org/cms/docs/marine/CCS%20Plan_chpt%207_web.pdf (p.173) - Torch/Platform Irene spill volume data.
10. http://www.etc-cte.ec.gc.ca/databases/TankerSpills/Default.aspx - Lists of spills around the world.
11. Probability of large spill.xls – calculates the probability of a large spill occurring.
12. CompiledData.xls – Compiled lists of spills.
13. CompiledDataAnalysisUpdatedRegression.xls – Compiled lists of spills with regression analysis.
14. SpillsInfo.xls – Additional list of spills includes spills which were not used in the analysis.

Appendix 5: The Benefit of Improved On-Water Removal[26]

One expected gain from the proposed rules is an increase in on-water removal before the oil impacts the shore and reducing the spread and creating greater resource damages. This reduction of impact is expected to be gained from the proposed rules requirement of early deployment for protective boom and on-water recovery equipment. Based on modeling of some worst case spills, Ecology expects that between 0% and 19% more of a large spill could be removed.

Table 5.1 Modeled removal of oil spills on the water

Percentage of Oil Removed	State minus Federal	Dispersants Minus State Removal	ISB Minus State Removal	3rd Option minus Federal
Min	-6.0%	-6.0%	-15.0%	**-13.0%**
Max	19.0%	0.0%	6.0%	10.0%
Mean	3.2%	-3.8%	-1.0%	2.1%

This gain in on water oil recovery comes from an expectation that more rapid deployment will improve removal. On-water recovery is more effective before it spreads, becomes entrained in a water column or turns into mousse. The rapid response impact has been modeled for a worst cases spill. The average results are displayed in Table 5.1.

Most of this research was done for 25,000 to 65,000 barrel spills. However, in the Phase II: Draft Report Volume I: Model Description, Approach, and Analysis February 2006 some worst damage runs allowed a change in the amount of oil spilled from 25,000 barrels to 250,000 barrels. The equipment and planning needed for a worst case spill will also help with smaller spills. The modeling effort produced few results for this. Table 5.2 displays the results from scenarios where it was possible to compare spill response by size of spill.

For large spills, the size of the spill overwhelms the required equipment and manpower, and the percentage gain in spill removal drops. The most comparable scenarios summarized in the table below are for the Juan de Fuca 250,000 barrel Crude and 25,000 barrel bunker spills. The reader can note that with the larger spill, almost twice as much oil is removed but the percentage share removed is reduced from 9.1% to 2.1% for the proposed state requirements. It can not be shown whether the implication of these two data points would magnify for much smaller spills. The results are similar for adding the

[26] Most of the data for this section was taken from worst case spill scenarios for 65,000 and 25,000 barrel spills. Evaluation of the Consequences of Various Response Options, Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters, Deborah French-McCay, Jill Rowe, Nicole Whittier, Subbayya Sankaranarayanan and Claudia Suàrez, Applied Science Associates, Inc. Dagmar Schmidt Etkin, Environmental Research Consulting, 2005, 2006

proposed state requirements to the federal program and for adding the Option 3 requirements to the state requirements.

Table 5.2: Percent of Hydrocarbon Mechanical Removal, Various Spills by Size and Type

Scenario	Average HC mechanical removal change for worst damage spills	Average HC mechanical removal change for 50 percentile spills
Outer Coast - Crude 250,000		
Duntz Rock		
Fed to WA	1.7%	
WA to Opt. 3	0.6%	
Juan de Fuca - Bunker 25,000		
Fed to WA	9.1%	
WA to Opt. 3	8.8%	
Juan de Fuca - Deisel 65,000		
Fed to WA	3.6%	
WA to Opt. 3	2.9%	
Juan de Fuca - Crude 250,000		
Fed to WA	2.1%	
WA to Opt. 3	1.9%	
Juan de Fuca - Crude 250,000		
Fed to WA		2.1%
WA to Opt. 3		1.6%
Lower Columbia - Bunker C 25,000		
Fed to WA	1.9%	
WA to Opt. 3	3.4%	
Upper Columbia - Bunker C 25,000		
Fed to WA	1.4%	
WA to Opt. 3	3.0%	
Outer Coast Sea Lanes - Bunker C 150,000		
Fed to WA	4.1%	
WA to Opt. 3	0.3%	
Grays Harbor - Bunker C 25,000		
Fed to WA	8.4%	
WA to Opt. 3	9.0%	

The data from these studies has helped frame our determination; however, there are limitations to the use of this data for this cost benefit analysis. This mathematical model does not fully simulate natural world processes. In other words, this model can not replicate natural world conditions or results because of the inherent assumptions that must be built into the model, and because we do not fully understand how most Earth processes work. The 50th percentile spill, based on shoreline impact, is not always the same one for each equipment level within each scenario. Thus for comparison purposes, one is comparing results for different spills. This creates several issues:

- This may be the reason that adding equipment, manpower, and dispersants or in-situ-burning generates negative effects for the percent of oil removed for some scenarios. Ecology does not believe these negative values would be seen in a real response. However, the effect can work in the opposite direction for some scenarios. Therefore Ecology is averaging the gains and losses across the scenarios.
- One issue is that this averaging does not necessarily help when evaluating the addition of dispersants and in-situ-burns. The in-situ-burns and dispersants will reduce the cost of spill response and should not reduce the removal of oil on water. These alternatives are treated as an addition to the state program for this analysis and therefore the averages themselves are also negative.
- These 50th percentile choices were based on extent of shoreline oiling. The reductions in shoreline oiling are greater than the reductions in on-water cleanup. If the shores are less oiled, then it is not likely that the alternatives actually reduce on-water removal. Some of the shoreline shift can be due to greater deployment of shoreline protection but not all of it. Again, Ecology questions these negative values in a real world spill and must consider this caution when making this analysis.
- Finally, it is unlikely that the estimated share of on-water removal that is attributed to federal requirements in the models is realistic. The guidance being incorporated into rules generates over 25% of the recovery equipment currently in use. Given a 65,000 barrel spill, it is unlikely that this much equipment is simply redundant. Further the speed of deployment is increased, making the equipment more effective, in the first crucial hours before oil spreads and recovery efficiency decreases.[27]It is unlikely that this contributes only 3% to the current levels of cleanup.

Once the estimated removal of oil spilled is complete for a 20 year set of spills, the estimate can be used to determine how much the damages have been reduced.

Table 5.3: Percentage Change in Hydrocarbon Removal for Scenarios by the following Contingency Planning Shifts: Federal to State Requirements, State Requirements to State plus dispersants, State Requirements to State plus In Situ Burning, and State Requirements to 3rd Option.

[27] The data for this section of the document draws heavily Response Cost Modeling for Washington State Oil Spill Scenarios Supplemental Information, Applied Science Associates, Inc. Dagmar Schmidt Etkin, Environmental Research Consulting, 2005, 2006.

Percent of spilled hydrocarbon mass mechanically removed and/or burned (%)										
	Run Result		**Change in 50th Percentile Run Based on Shore Costs**				**Change in Mean**			
Scenario	50th Run Based on Shore Costs	Mean	State Minus Federal Removal	Dispersants Minus State Removal	ISB Minus State Removal	3rd Option Minus State Removal	State Minus Federal Removal	Dispersants Minus State Removal	ISB Minus State Removal	3rd Option Minus State Removal
OC-Crud-N	-	-								
OC-Crud-R-ST-base	65	65	1%				19%			
OC-Crud-R-Fed	64	46								
OC-Crud-R-3	67	52				2%				-13%
OC-Crud-R-ISB	66	50			1%				-15%	
OC-Crud-C-ST-base	59	59		-6%				-6%		
OC-Crud-C-Fed	57	43								
OC-Crud-C-3	59	48				0%				-11%
S1-Bunk-N	-	-								
S1-Bunk-R-ST	88	85	1%				-2%			
S1-Bunk-R-Fed	87	87								
S1-Bunk-R-3	93	91				5%				6%
S1-Bunk-R-ISB	88	91			0%				6%	
S1-Dies-N	-	-								
S1-Dies-R-ST	71	48	9%				1%			
S1-Dies-R-Fed	62	47								
S1-Dies-R-3	76	58				5%				10%
S2-Crud-N	-	-								
S2-Crud-R-ST	68	67	3%				2%			
S2-Crud-R-Fed	65	65								
S2-Crud-R-3	67	72				-1%				5%
S2-Crud-R-ISB	69	68			1%				1%	
S2-Crud-C-ST-base	66	64		-2%				-3%		
S2-Crud-C-Fed	64	58								
S2-Crud-C-3	67	66				1%				2%
SI-Crud-N	-	-								
SI-Crud-R-ST	67	68	2%				6%			
SI-Crud-R-Fed	65	62								
SI-Crud-R-3	70	70				3%				2%
SI-Crud-C-ST-base	67	66		0%				-2%		
SI-Crud-C-Fed	65	60								
SI-Crud-C-3	70	71				3%				5%
IS-Crud-N	-	-								
IS-Crud-R-ST	72	69	5%				5%			
IS-Crud-R-Fed	67	64								
IS-Crud-R-3	76	72				4%				3%
IS-Crud-C-ST-base	66	64		-6%				-5%		
IS-Crud-C-Fed	61	56								
IS-Crud-C-3	70	68				4%				4%
C1-Bunk-N	-	-								
C1-Bunk-R-ST	82	76	4%				1%			
C1-Bunk-R-Fed	78	75								
C1-Bunk-R-3	82	80				0%				4%
C2-Bunk-N	-	-								
C2-Bunk-R-ST	78	73	0%				-6%			
C2-Bunk -R-Fed	78	79								
C2-Bunk -R-3	80	78				2%				5%
Average			3%	-4%	1%	2%	3%	-4%	-3%	2%

Appendix 6: Benefit of Reduce Shoreline Impacts

What oil is collected on water will not ultimately strand on the shorelines of the state.[28] Table 6.1 indicates the percentage reduction estimated by the modeling scenarios. In general, the modeled state requirements reduce the total shoreline impact 7% when compared with the federal requirements. In-situ-burning and dispersants also reduce shoreline oiled.

Table 6.1: Percentage Reduction in the area of Shoreline Oiled by Area and Type of Additional Effort

Percentage Reduction in Area of Shoreline Oiled				
	Add State Effort	Add ISB	Add Dispersants	Add 3rd Option
Outer Coast - Crude	5%	3%	-6%	-8%
Strait of Juan de Fuca - Bunker C	0%	55%		38%
Strait of Juan de Fuca - Deisel	0%			14%
Strait of Juan de Fuca - Crude	6%	17%	9%	12%
San Juan Island - Crude	17%		-9%	6%
Inner Strait Crude	-6%		11%	-19%
Lower Columbia - Bunker C	40%			-50%
Upper Columbia - Bunker C	-4%			2%
Average	7%	25%	1%	-1%

Note: minus signs mean an increase in shoreline oiled.

Table 6.2 shows that most scenarios indicate an increase in the percentage of shoreline that is more lightly oiled. In general the state requirements increase the percentage of the shoreline that is lightly oiled by 8% when compared with the federal requirements. In-situ-burning, dispersants, and the 3rd option requirements also increase the percentage of the shoreline oiled, which only have the light oiling, thus reducing the cost per square meter of cleanup.

[28] The data for this section of the document draws heavily on Evaluation of the Consequences of Various Response Options, Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters, Deborah French-McCay, Jill Rowe, Nicole Whittier, Subbayya Sankaranarayanan and Claudia Suàrez, Applied Science Associates, Inc. Dagmar Schmidt Etkin, Environmental Research Consulting, 2005, 2006.

Table 6.2: Change in the percentage of shoreline with light oil and lower cleanup costs by area and type of effort.

Change in percent of Shoreline <1000 g/m2				
	Add State Effort	Add ISB	Add Dispersants	Add 3rd Option
Outer Coast - Crude	-2%	5%	5%	8%
Strait of Juan de Fuca - Bunker C	0%	0%		0%
Strait of Juan de Fuca - Deisel	17%			29%
Strait of Juan de Fuca - Crude	22%	24%	6%	-19%
San Juan Island - Crude	4%		2%	2%
Inner Strait Crude	24%		19%	26%
Lower Columbia - Bunker C	-1%			0%
Upper Columbia - Bunker C	3%			0%
Average	8%	10%	8%	6%

The cost per square meter of shoreline cleanup varies based on the level of oiling. For heavy oils the average cost of cleaning up heavily oiled beach is 3.1 times more than cleaning up a lighter oiling. For light oils the cost is 1.8 times higher.

Table 6.3. Shoreline Cleanup Costs

Shoreline Cleanup Cost Factors						
Oil Type	Bunker C		Diesel		ANS Crude	
Shoreline Type	<1 mm	>1 mm	<1 mm	>1 mm	<1 mm	>1 mm
Rocky shoreline	$14	$78	$2	$4	$7	$39
Gravel beach	$20	$140	$3	$5	$10	$70
Sand beach	$24	$78	$3	$6	$12	$39
Mud flat	$70	$156	$10	$18	$35	$78
Wetland	$80	$172	$11	$21	$40	$86
Artificial	$8	$46	$1	$2	$4	$23
Year 2003 $ per m2. Not including disposal costs						

Appendix 7: Benefits of Reduce Environmental and Socioeconomic Cost of Spills

The impacts of oil spills can be reduced to some extent by quick response times if the response is capable of protecting geographic areas that are important or if a substantial share of the oil is removed on water before it has a chance to create harm. In general the gains for heavier oil may be greater since lighter, persistent oils create long term toxic and mechanical impacts. [29] Each of the reducible damages is addressed by some part of the proposed rules. The value of these damages is estimated in table 7.1 below.

Table 7.1: Environmental and Socioeconomic Damage Estimates

Costs by Quantity and Oil Type			
		Environmental Damage	Socioeconomic Cost
Oil Type	Volume (Gallons)	2005$ / Gallon	2005$ / Gallon
	<500	$51	$69
	500-1,000	$48	$281
	1,000-10,000	$37	$425
Volatile Distillates	10,000-100,000	$32	$191
	<500	$90	$85
	500-1,000	$85	$350
	1,000-10,000	$74	$531
Light Fuels	10,000-100,000	$69	$212
	<500	$101	$159
	500-1,000	$96	$637
	1,000-10,000	$90	$955
Heavy Oils	10,000-100,000	$80	$531
	<500	$96	$53
	500-1,000	$92	$212
	1,000-10,000	$85	$318
Crude Oil	10,000-100,000	$77	$149

The weighted average of these costs provides an estimate of the value that may accrue for removal on an overall per gallon basis for a large number of spills. The costs were weighted based on the share of spills in each of the sized classes. Further weighting by the shares of light and heavy oils give an average value of $124 per gallon for socioeconomic damages and $86 for environmental losses.

[29] Etkin, Dagmar Schmidt, 2005, "Socioeconomic Cost Modeling For Washington State Oil Spill Scenarios: Part II", Environmental Research Consulting.

Table 7.2: Weighted Average of Environmental and Socioeconomic Costs

Volume (Gallons)	Percent of Spills	Environmental Average		Socioeconomic Average	
		Light Oils	Heavy oils	Light Oils	Heavy oils
<500	98.19%	$71	$ 101	$77	$ 150
500-1,000	0.55%	$67	$ 96	$316	$ 600
1,000-10,000	0.63%	$56	$ 90	$478	$ 899
10,000-100,000	0.50%	$51	$ 80	$202	$ 497
>100,000	0.24%	$51	$ 80	$202	$ 497
Weighted Average of Costs		$70.31	$100.42	$81.84	$159.61
Overall Weighted Average			$86.75		$124.30

Running 7000 spills allows Ecology to use this weighted average. The larger savings come from the larger spills.

Appendix 8: Stockholder Losses

Exxon Valdez			
Breakdown of costs of the spill that generated the law:			
Note this assumes industry absorbed all the costs of the spill			
	Low	**Medium**	**High**
Spill Size - gallons		11,000,000	
EXXON - Stock holder losses	$ 4,700,000,000	$ 8,000,000,000	$ 11,300,000,000
Lost Oil, salvage and repair of vessel		$ 30,000,000	
Out of court settlement		$ 1,150,000,000	
Fines		$ 25,000,000	
Waterway Restoration		$ 100,000,000	
Other impacts			
Wealth Loss other stockholders		$ 9,800,000,000	
Alaska Tax Code Changes		$ 2,000,000,000	
Chevron Improvements		$ 350,000,000	
Oil Industry rapid response locations		$ 250,000,000	
PV Foregone - Arctic Refuge Not Opened for 16 years		$ 7,098,813,637	
Total Industry Impacts	$ 27,100,000,000	**$ 30,400,000,000**	$ 33,700,000,000
Cost per gallon		**$ 2,764**	

Appendix 9: Monte Carlo Calculations

A Monte Carlo is a method of estimating the impact of a set of variables that do not necessarily move together, where simple multiplication of means may not generate a mean value. The model is deterministic in that the distributions for each variable are preset. The model then varies each variable at random and generates the specified number of results and generates descriptive statistics. The calculations move from detailed data to final estimates with mathematics. The model has an imbedded Monte Carlo that allows the amount of oil spilled, the weight of the oil, and the percent of on-water recovery to vary.

Inputs to the model and their ranges:

1. Respondent Costs: Individual survey data is summed into total value of costs for equipment, training, contracts, and drills. This value was not allowed to vary. Ecology would welcome feedback on whether or not companies will share equipment with each other and/or give Ecology data to determine alternative delivery speed for equipment they plan to use. These values could generate different costs.
   - Drill costs are the cost of a new limited deployment drill minus the cost of the full scale unannounced deployment drill that is no longer required.
   - For response contractor the reported total costs for contracts and agreements, training, and equipment, are assigned a state share and a federal share based on the share of existing equipment that is attributable to a state requirement.
2. The distribution of the amount of oil spilled was determined by the data on spill sizes using the data in the Monte Carlo run displayed below.
3. A calculation takes out 23% of the spills, which are handled by the Washington State Oil Transfer Rules. These are subtracted from spills lower than 5,500 gallons.
4. The oil is divided into heavy and light oil based on the data in Appendix 5. More detail could be incorporated in the final CBA.
5. The on-water recovery for heavy and light oil and for large and small spills was allowed to vary based on the results in Appendix 5. This is a critical assumption here and the model is sensitive to it. If on-water recovery were allowed to move in proportion with the state share of equipment and costs, then the benefits would be nearly an order of magnitude higher.
6. Shoreline cleanup cost reductions are calculated based on on-water recovery for heavy and light oil and for large and small spills. This calculation is multiplied by a weighted average of cleanup costs from Appendix 6 given the modeled estimated reduction in shoreline oiled and the increased share of the area with reduced oiling.
7. Environmental and socioeconomic damage reductions are calculated based on the average value in Appendix 7. This calculation is multiplied by a weighted average of the environmental and socioeconomic costs of spills.
8. The shoreline cleanup savings and the damage reductions are summed to obtain the gains from additional removal of oil from typical spills.

9. The value of a large spill varies based on the percentage removal and the costs are set based on the per gallon costs of the Exxon Valdez spill displayed in Appendix 8, multiplied times 2.7 million gallons, which is the size that Ecology selected as the worst case spill for the worst case modeling effort.
10. An additional set of Passive Use Loss values were generated by the model based on the California and Exxon Valdez values discussed in section 5.7.
11. Present values were calculated for all summed benefits using the social rate of time preference. Equipment purchases were handled with a multiplier taking into account both the social rate of time preference and the 8% prime rate. Estimated values were done assuming a 20 year lifespan for the proposed rules.

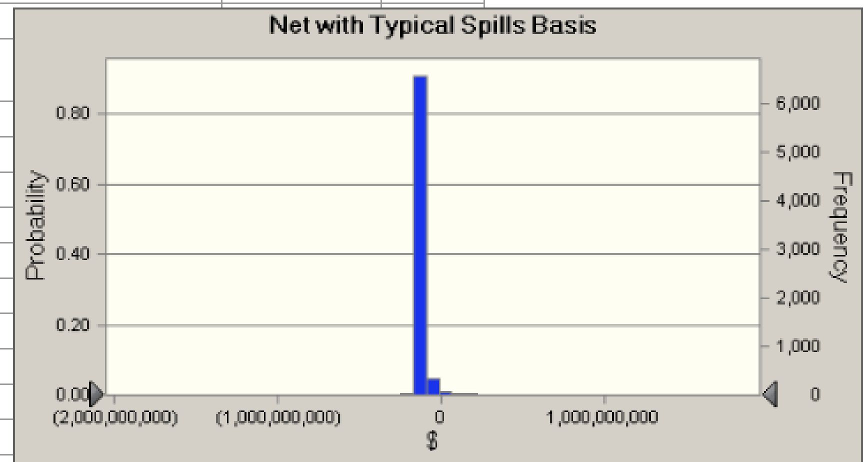
Table 9.1: The Monte Carlo Model: Displaying the calculations based on average values only.

Monte Carlo Spills Basis	540	Average size of spill and distribution		
Percentage of Oil Removed	State minus Federal	Dispersants Minus State Removal	ISB Minus State Removal	3rd Option minus Federal
Min	-6.0%	-6.0%	-15.0%	**-13.0%**
Max	19.0%	0.0%	6.0%	10.0%
Mean	3.2%	-3.8%	-1.0%	2.1%
Monte Carlo percent reduction basis	3.2%	-3.8%	0.3%	2.1%
Crystal Ball Distribution	Beta dist best fit by Chi Square	Insf data to select: direct frequency	Insf data to select: direct frequency	Student t best fit by Chi Square
Size of spill Adjustment	4.3			4.6
Reduced Shore Oiling	7%	1%	25%	-1%
Reduced Thickness	8%	8%	10%	6%
Reduced Shore Oiling - Meters	2,865	(1,152)	41	6,048
Reduced Thickness - Meters	3,772	3,913	4,627	2,357
Oil Removed at Spill	42.0	(21)	0.7	107.7
Total 20 Year Oil Reduction	233,511	(93,876)	3,365	492,899
Basis Typical Spills				
Shoreline Cleanup Savings	$320,462	$56,262	$160,508	$485,382
Socioeconomic and Environmental	$ 40,518,229	$ (16,289,122)	$ 583,836	$ 85,526,607
Sum without Very Large Spill	$ 40,838,691	$ (16,232,860)	$ 744,344	$ 86,011,989
Basis Very Large Spill	$ 198,491,324	$ (235,708,447)	$ 18,608,562	$ 130,259,931
Sum with Very Large Spill	$ 239,330,015	$ (251,941,307)	$ 19,352,906	$ 216,271,920
Passive Use Value Exxon Study	*$ 191,231,590*	*$ (227,087,513)*	*$ 17,927,962*	*$ 125,495,731*
California Passive Use Study	*$ 20,905,600*	*$ (24,825,400)*	*$ 1,959,900*	*$ 13,719,300*
Cost of Proposed rule	$ 113,101,018			$ 101,768,553
Net with Very Large Spill Basis	126,228,997	(251,941,307)	19,352,906	103,170,902
Net with Typical Spill Basis	(72,262,327)	(16,232,860)	744,344	(191,633,973)

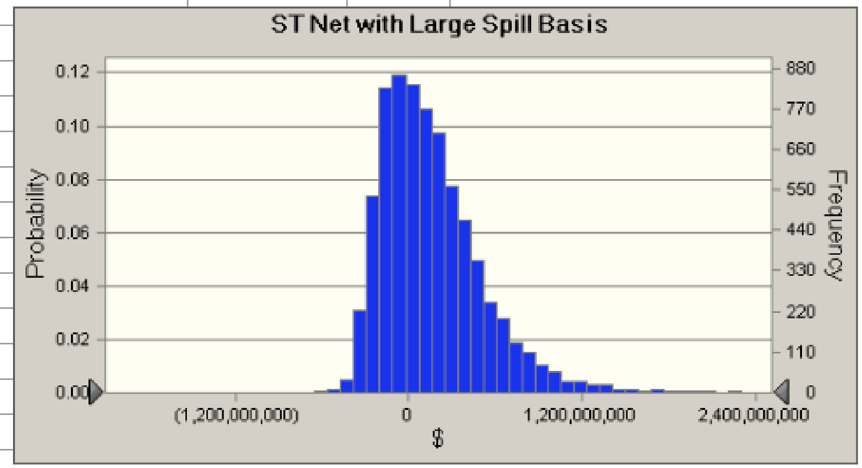
Results:
When using a simple multiplication of means, the present value of the probable quantitative net is either $126 million or -$72 million, depending on whether there is a large spill. Note that this does not include the reduction in passive use losses, which are difficult to extrapolate.

The following tables provide the Monte Carlo run:

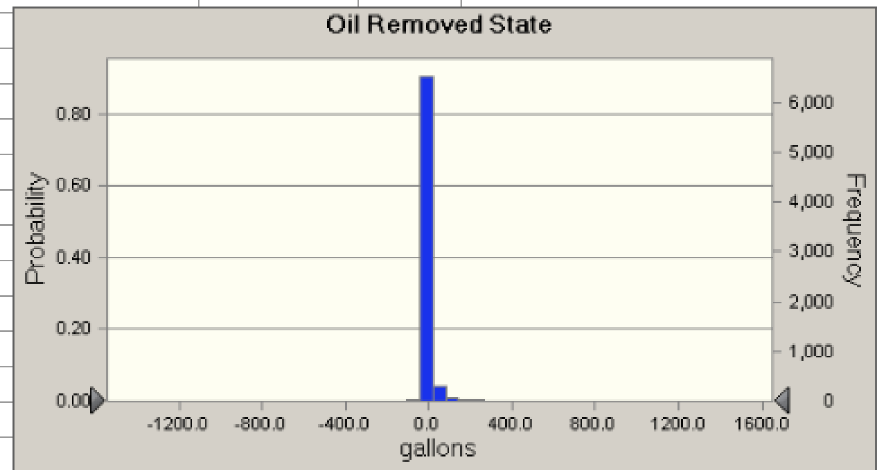
Forecast: Net with Typical Spills Basis		Cell: S32
Summary:		
Entire range is from (7,754,451,498) to 22,195,386,811		
Base case is (72,262,327)		
After 7,227 trials, the std. error of the mean is 7,996,828		
Statistics:	Forecast values	
Trials	7,227	
Mean	(55,225,866)	
Median	(111,281,062)	
Mode	---	
Standard Deviation	679,824,431	
Variance	462,161,257,036,060,000	
Skewness	19.85	
Kurtosis	527.03	
Coeff. of Variability	-12.31	



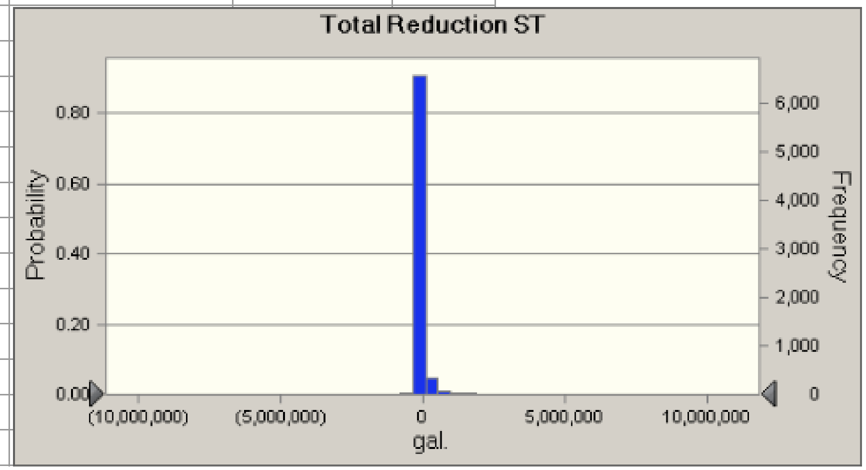
Forecast: ST Net with Large Spill Basis		Cell: S31
Summary:		
Entire range is from (7,916,249,579) to 22,933,422,563		
Base case is 126,228,997		
After 7,227 trials, the std. error of the mean is 9,219,225		
Statistics:	Forecast values	
Trials	7,227	
Mean	201,305,517	
Median	99,114,567	
Mode	---	
Standard Deviation	783,742,607	
Variance	614,252,474,523,384,000	
Skewness	14.42	
Kurtosis	339.61	
Coeff. of Variability	3.89	



		Cell: S15
Forecast: Oil Removed State		
Summary:		
Entire range is from -6085.6 to 17697.9		
Base case is 42.0		
After 7,227 trials, the std. error of the mean is 6.4		
Statistics:	Forecast values	
Trials	7,227	
Mean	49.1	
Median	1.9	
Mode	---	
Standard Deviation	542.3	
Variance	294093.9	
Skewness	19.53	
Kurtosis	515.20	
Coeff. of Variability	11.05	
Minimum	-6085.6	
Maximum	17697.9	
Range Width	23783.5	
Mean Std. Error	6.4	
Percentiles:	Forecast values	
0%	-6085.6	
10%	-1.0	
20%	-0.2	
30%	0.5	
40%	1.2	
50%	1.9	
60%	2.7	
70%	3.8	
80%	5.7	
90%	13.9	
100%	17697.9	



Forecast: Total Reduction ST	Cell: S16
Summary:	
Entire range is from (43,978,735) to 127,896,885	
Base case is 233,511	
After 7,227 trials, the std. error of the mean is 45,840	
Statistics:	Forecast values
Trials	7,227
Mean	331,219
Median	10,399
Mode	---
Standard Deviation	3,896,918
Variance	15,185,969,921,994
Skewness	19.85
Kurtosis	527.33
Coeff. of Variability	11.77



Forecast: Display actual spills for run		Cell: G5428
Summary:		
Entire range is from 18 to 323737		
Base case is 540		
After 7,227 trials, the std. error of the mean is 72		
Statistics:	Forecast values	
Trials	7,227	
Mean	561	
Median	19	
Mode	18	
Standard Deviation	6102	
Variance	37230330	
Skewness	31.58	
Kurtosis	1,350.65	
Coeff. of Variability	10.87	
Minimum	18	
Maximum	323737	
Range Width	323718	
Mean Std. Error	72	
Percentiles:	Forecast values	
0%	18	
10%	18	
20%	18	
30%	18	
40%	18	
50%	19	
60%	19	
70%	23	
80%	44	
90%	213	
100%	323737	

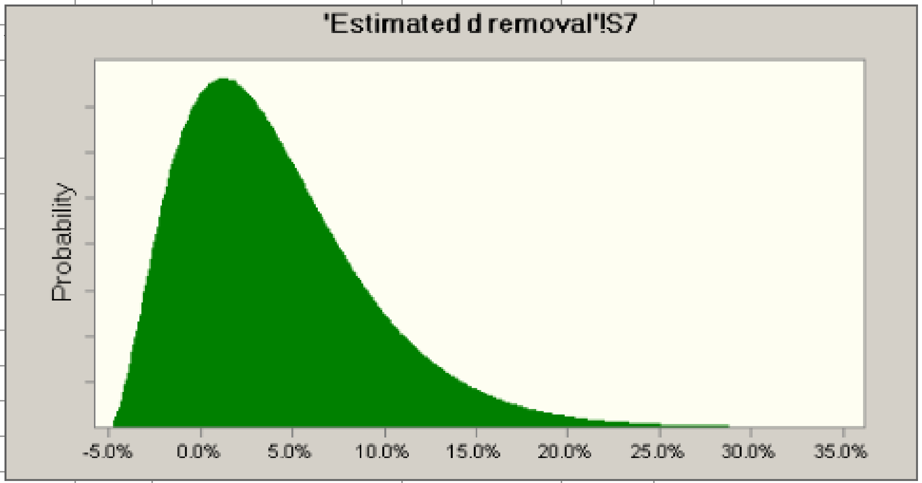
Assumptions

Worksheet: [Ph1 Distribution for spill removal selected change comparison

Assumption: S7

Beta distribution with parameters:

Minimum	-5.1%
Maximum	304.6%
Alpha	3.04188052
Beta	100



Assumption: U44

Yes-No distribution with parameters:

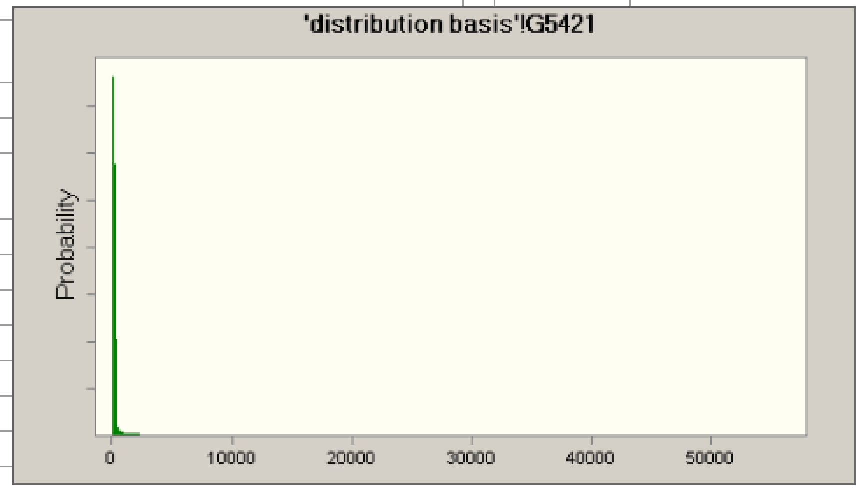
Probability of Yes(1)	0.454
Heavy	Light

Worksheet: [Spilldata5sourcesduplicatesremovedNoDuplicates.xls]distribution basis

Assumption: G5421

Weibull distribution with parameters:

Location	18
Scale	2
Shape	0.179158778



Given the above runs of the Monte Carlo, the expected probable value of net costs (see yellow) is $55 million for a 20 year period with no spill in the 65 thousand barrel range. With such a spill the expected probable value of net benefits is $201 million. This would imply that with a frequency of one major spill every 100 years or so, the probable benefits would outweigh the probable costs.

The costs of the rules are currently being covered by companies that pass on the cost of compliance to their customers. The average household in the state is probably paying between $3 per year for the state program and $15 for all the state and federal contingency planning efforts.

Ecology generated more than one calculated value of probable benefits:

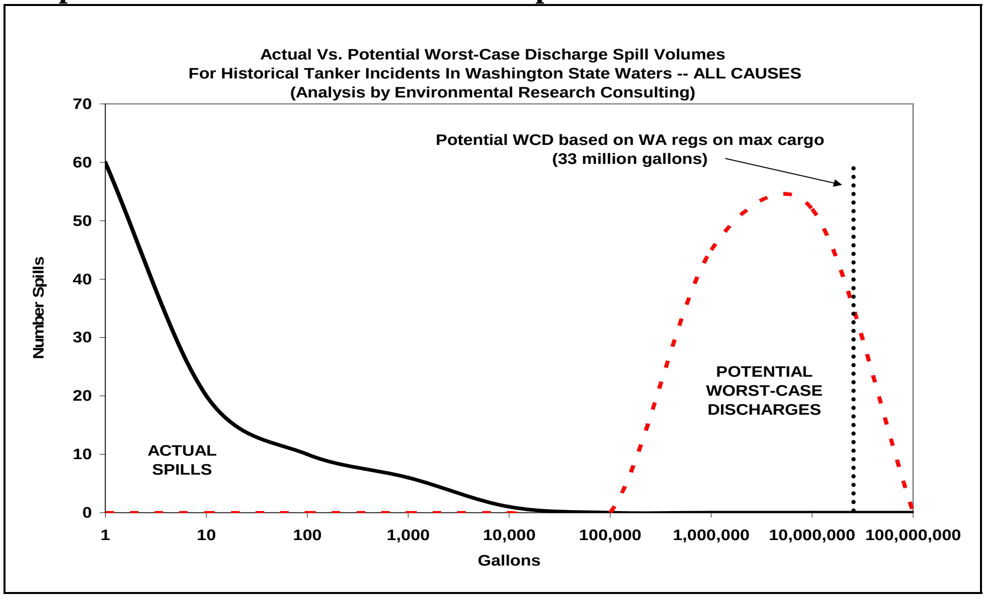
- Ecology constructed a formula in order to determine the gain from contingency planning. This was: Gain = Size of spill x percent removed x damage prevented.
- Damage prevented was calculated based on both economic and environmental damages avoided, and an Exxon Valdez comparison of level of damages.
- The gains for typical spills can be subtracted from the costs.
- The remainder is the value that would need to be generated from a large spill, with an unknown likelihood of occurring.
- There are two passive use studies that also provide information for our analysis.

The following sections describe how Ecology extrapolated the size of spills, the percentage of any given spill that would be removed, the value created by that removal through damages prevented. These were used to estimate the gains for on water cleanup of typical spills and the costs that must be covered by a potential large spill.

Worst Case vs. Smaller Spills

Worst case spills are a modeled target for planning for each plan holder. In the real world in most cases, some share of the oil contained in the tank or pipeline will not spill unless a truly catastrophic event occurred (such as an earthquake).

Graphic 9.2: Actual and Worst Case Spills[30]



The law requires a rule that addresses worst case spills. [31] A worst case spill has both a larger size and a lower probability than an average or typical spill. By way of illustration this graphic shows the difference between what has historically spilled and what could have spilled in a worst case event. The overlap of the two distributions is minimal. Given the complexity of addressing this issue Ecology contracted [32] out analysis of the following areas:

- Response Cost Modeling for Washington State Oil Spill Scenarios Executive Summary
- Response Cost Modeling for Washington State Oil Spill Scenarios Supplemental Information
- Socioeconomic costs Cost Modeling for Washington State Oil Spill Scenarios
- Modeling of Washington State Oil Spill Scenarios Phase III: Outer Coast/Grays Harbor
- Phase I: Evaluation of the Consequences of Various Response Options Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters, Volumes 1-26[33]

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[30] Dagmar Etkin: excel spreadsheet.

[31] RCW 90.56.010 Definitions. RCW 90.56.210 Contingency plans. RCW 88.46.010 Definitions. RCW 88.46.060 Contingency plans. RCW 90.56.060 Statewide master oil and hazardous substance spill prevention and contingency plan--Evaluation and revision or elimination of advisory committees.

[32] Dagmar Schmidt Etkin, Environmental Research Consulting.

[33] This report contains the results of the Phase I study. It was updated from an earlier draft report, submitted to WDOE in July 2004. However, the comparison of the results from Phase I with Phase II is contained in the Phase II report. Additional presentation and discussion of the Phase I results for the Outer Coast at Duntz Rock scenario is in French et al. (2005a) and Etkin et al. (2005b).

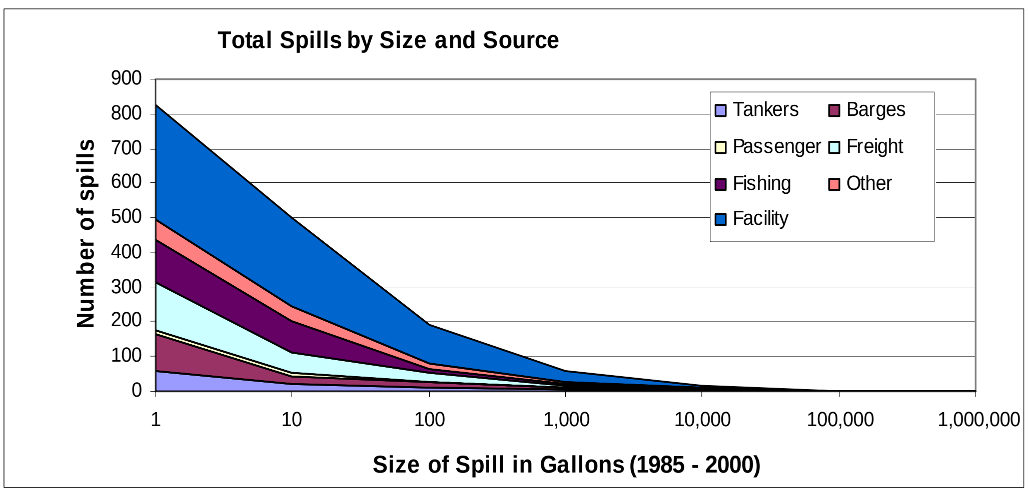
- Phase II: Draft Report Evaluation of the Consequences of Various Response Options Using Modeling of Fate, Effects and NRDA costs for Oil Spills into Washington Waters, Volumes 1-29

Defining the Sizes of Spills for the Distribution

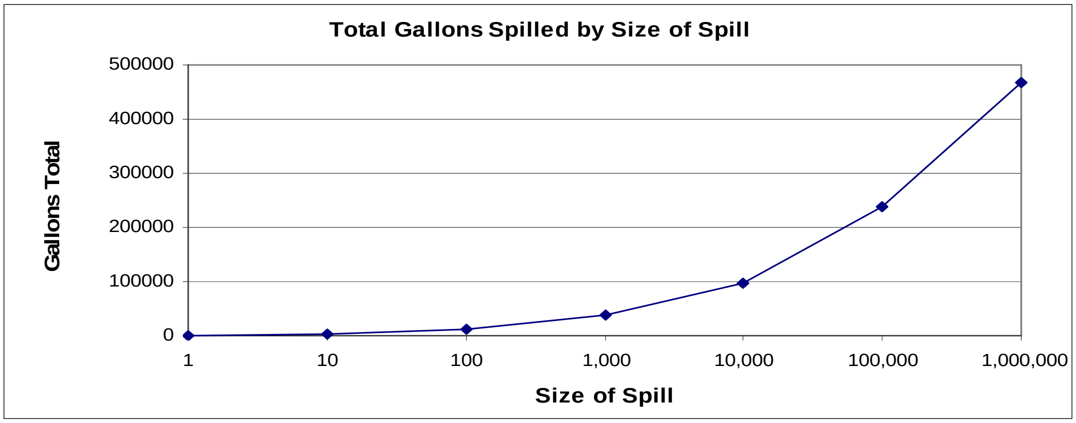
The gains from spill response are in part defined by the set of spills to which plan holders will have to respond. A frequency distribution based on past spills was developed in order to estimate future spills in Washington for the next 20 years. This frequency distribution forms one underlying basis for estimating the probable benefits of the proposed rules. It is used in a Monte Carlo that generates over 7000 spills in a probabilistic fashion from small to relatively large ones. This is taken to represent approximately 20 years worth of spills.

Nearly every sector that uses oil has had a spill. For each sector there are more small spills into water than large ones. Graphic 9.3 presents the number of spills on the y axis. These are arranged by size and assigned to the sectors generating the spill. As shown in Graphic 9.4, despite the small number of large spills, the large spills put more oil in the water.

Graphic 9.3: Total Numbers of Spills by Size and Source

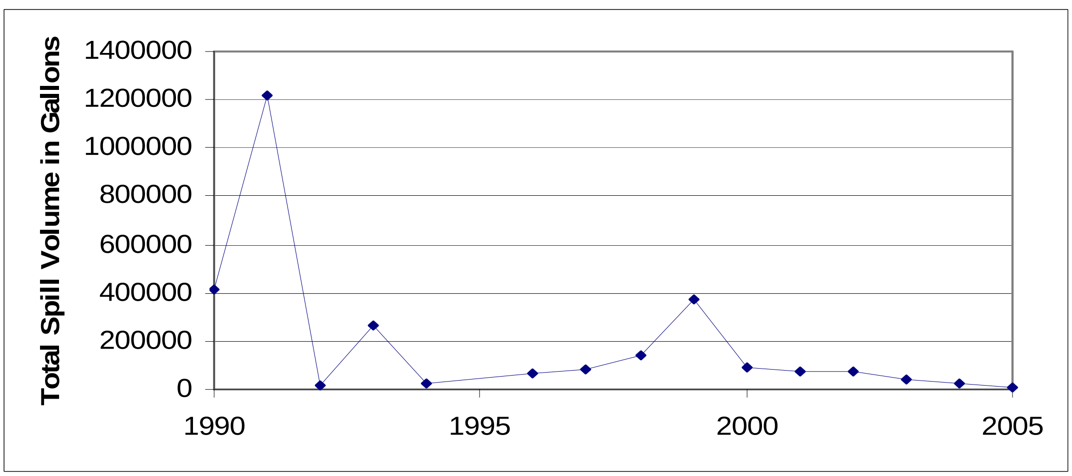


Graphic 9.4: Total Gallons Spilled by Size of Spill



Given that a few large spills generate more volume than many small spills, the volume for any given year depends largely on how many large spills occur. The total amount of oil spilled each year yields erratic volumes. This uncertainty about the volume of any given spill is added to by uncertainty as to the time and place that a spill will occur. Graphic 9.5 presents annual spillage summarized from a composite data base[34] of over 5,400 spills.

Graphic 9.5: Total Spillage, All Types of Oil, by Year



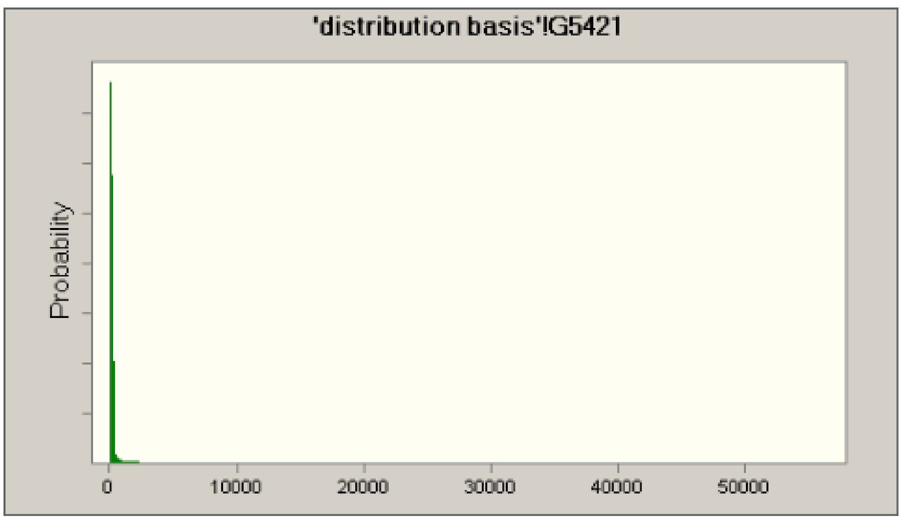
Ecology used the data on past spills to generate a distribution that was then used to model spill frequency and size. Ecology is seeking additional data to improve this estimate for the final CBA.

[34] The data included Ecology data and Coast Guard data on dates, times, and amounts spilled.

Table 9.6: Number of spills by gallons of size, percentage of total spills, and total volume of spillage.

Spill Size	Count	% of spills	Total Spillage
10	4440	81.95%	44400
50	604	11.15%	30200
100	136	2.51%	13600
500	140	2.58%	70000
1000	30	0.55%	30000
5000	28	0.52%	140000
10000	6	0.11%	60000
50000	24	0.44%	1200000
100000	3	0.06%	300000
500000	6	0.11%	3000000
1000000	7	0.13%	7000000

Graphic 9.7: Illustration of the distribution used to generate an estimate of the impact of spills for a 20 year period.



The distribution used to model 20 years of spills is a Weibull distribution with parameters: Location = 18, Scale = 2, Shape = 0.179. Mathematically, the distribution indicates there are many small spills but that the frequency of spills drops rapidly as the size of spill being modeled increases. The distribution incorporates a few larger spills and thus it has a long tail.

Based on this data it is also possible to determine the share of light, crude and heavy oils that have been spilled in the last few years.[35] This has been used to apply average values to the spills generated by the distribution. Ecology assumes that 45.4% of the spills are light oil, 4.8% are Crude, and the remaining 49.8% are heavy oils. These percentages

[35] Discussion with Dagmar Etkin, 8/5/04.

will be applied to the diesel, crude, and bunker oil scenarios modeled in the reports listed on page 14.

This 15 year history was used to extrapolate the effects of 20 years worth of spills, using a Monte Carlo. This set of spills is then used to estimate the effects of removing more oil on the water, before it hits the shore.